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The Agricultural Chemist at the Table: Land Grant Colleges, Experiment Stations, and the Birth of Nutrition Science in the United States, 1887-1930

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By

Kimberly Killion

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Committee in charge:

Professor Rebecca McLennan, Chair
Professor Cathryn Carson
Professor Kathryn De Master

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Abstract

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This dissertation examines the often-overlooked work of scientists investigating nutrition at land-grant colleges and agricultural experiment stations in the mid to far West, especially in Wisconsin and California, from 1887 to 1930. It challenges the historiography's dominant narrative that nutrition science was exclusively laboratory-based and quantitatively-focused; that it was primarily a tool of social control; and that it was chiefly the work of scientists and reformers in the urban Northeast. Rather, I argue, chemists working at land grant colleges and experiment stations around the nation forged a holistic tradition of nutrition research that countered the reductionist views of the Northeast's "pure" and industrial scientists and urban reformers. Chemists working in the agricultural tradition were skeptical of the ability of quantitative methods alone to assess nutritional value. They placed a value on taste, pleasure, and custom in their approach to nutrition and expressed caution over the use of new industrially-processed foods and preservatives. They were concerned not only for the health of consumers, but also about the impact of new industrial foods and food systems on their farming constituents. They worked assiduously for the passage of pure food and drug laws. Nutrition science itself was transformed by their pioneering vitamin experiments.

Drawing on the archival papers of chemists investigating nutrition at the agricultural colleges and experiment stations in the Midwest and California, I trace the rise and fall of the agricultural tradition of nutrition science through five significant events in nutrition science in the United States from the 1880s to the 1920s. These events include the first USDA dietary surveys of the 1890s; the debates over pure food laws leading up to the Pure Food and Drug Act of 1906; precursors to and early vitamin experiments in the 1910s; the work of scientists in the U.S. Food Administration during the First World War; and food fortification research and university-industry partnerships at the University of Wisconsin in the 1920s. I explain how these chemists investigated nutrition questions, framed their understanding of healthful diets, and positioned their role in relation to farmers, consumers, processors, and government in the increasingly industrial food system throughout these events. Shifting the focus from nutrition workers and urban reformers in the Northeast to agricultural chemists in the Midwest and California, my dissertation also positions the development of the science in the changing agricultural landscape and industrializing food system. Finally, I show how this history challenges the linear narratives that have dominated the historiography, how it reveals an alternative possible trajectory for the science, and how it significantly shaped the development of nutrition science and its role in American society.

For Dominic and Ada

Table of Contents

List of Illustrations

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Introduction: The Agricultural Tradition of Nutrition Science in the United States

In 1899, University of California professor Myer Jaffa stepped up in a room of farm men and women in the San Joaquin Valley in California to give a lecture titled "Suggestions for the Home Table." Jaffa, an agricultural chemist who had worked at the California state agricultural experiment station since its founding in 1888, specialized in the study of human and animal nutrition, and used his laboratory to conduct dietary investigations and analyze the chemical components of food. Yet Jaffa's lecture to the farming men and women considered more than simply the chemical constituents of diet—and in fact, he warned against an approach to nutrition that only considered fats, proteins, carbohydrates, and calories. The science was "in its infancy," he emphasized, and "it has not been so thoroughly investigated as to justify anyone laying down cast-iron rules and regulations to be followed by any class of people, much less by all classes of people." Moreover, Jaffa argued, chemical nutritional standards did not consider important factors like taste, custom, and digestibility. "It would be more than foolish," Jaffa argued, "for a person to attempt to eat entirely according to dietetic tables without regard to his mode of life, his previous habits, his state of health, and his known idiosyncrasies of taste and digestion." Jaffa stressed that "The most nutritious food on the list would certainly not be beneficial to a man who had a distaste for it or did not digest it well." In the lecture, Jaffa did use a quantitative, chemical approach to nutrition to offer suggestions and explain common dietary pitfalls (such as only giving a toddler starchy carbohydrates), but his approach was neither strict nor scientifically reductionist. He concluded that many "will find that their natural tastes have guided them in the choice of a truly well balanced ration."[1]

This lecture is noteworthy not only for its author's holistic approach to the study of nutrition, but also for its setting—a farmers' institute. Farmers' institutes were lecture forums organized by state universities and farm groups throughout the United States beginning in the late nineteenth century, that mixed academic faculty and local community speakers. The institutes were particularly popular in California in the 1890s and early 1900s,[2] and Jaffa was a frequent and well-liked speaker. A champion of the state's pure food and drug law and the first director of the California Food and Drug Laboratory, Jaffa gave lectures on human nutrition, the "rational feeding" of poultry and other farm animals, and on food adulteration.[3] Beyond the lectern, as well, Jaffa sought to serve California's farming population: he helped dairymen form cooperatives, exposed fraudulent practices of food and animal feed manufacturers, and promoted the health value of California farm products (Figure 1).[4] Actively engaged in research, educational outreach, and advocacy, Jaffa consistently moved between his laboratory work and his audience of farmers, though sometimes he expressed frustration with this duty. "I think [the Farmers' Institute work]

[1] "'Suggestions for the Home Table,' paper by Prof. Jaffa, Read at the Farmers' Institute in Porterville, February 11, 1899," *The Porterville Enterprise* (Porterville, CA), March 31, 1899, Myer Edward Jaffa papers, BANC MSS C-B 1013, The Bancroft Library, University of California, Berkeley. (Hereafter, Jaffa Papers, Bancroft Library.)

[2] Charles Postel, *The Populist Vision* (Oxford; New York: Oxford University Press, 2007), 55–56.

[3] Newspapers reporting on his lectures noted that he was a popular speaker: "Poultry Man to be an Attraction," *Merced County Sun* (Merced, CA), April 28, 1911; "Azusa: Farmers' Institute," *Los Angele Herald,* September 24, 1898. Courtesy of the California Digital Newspaper Collection, Center for Bibliographic Studies and Research, University of California, Riverside (Hereafter, California Digital Newspaper Collection).

[4] For example, he spoke at a meeting with dairymen on forming a cooperative creamery: "Pure-Food Meeting To-day" *The Evening Post* (Stockton, CA), May 29, 1897, Jaffa Papers, Bancroft Library. Jaffa's campaign against food adulteration and promotion of California products are discussed in Chapters 1-3.

interesting, instructive, and very necessary," he wrote to Wilbur Atwater in 1901, "but to be called from the lab to the Institute and then back again is not conducive to the best work within the field."[5]

Figure 1: "California Raisin Day," *San Francisco Examiner,* April 30, 1909, Jaffa Papers, Bancroft Library. Jaffa's research in nutrition often supported the products of California's burgeoning horticultural landscape during this period. He especially promoted the health value of fruit and nuts.

[5] Myer Jaffa to Wilbur Atwater, September 10, 1901, Jaffa Papers, Bancroft Library.

Jaffa's audience of farmers for his work in nutrition science was not unique to him. Most histories of nutrition science during this era, however, contextualize the development of nutrition science in the rise of the urban working class, and examine the work of scientists and reformers in the Northeast. There is good reason for this. The earliest laboratory investigations of nutrition in the United States were based in this region, especially in the laboratory of Wilbur Atwater at the Storrs Experiment Station in Connecticut. Atwater, known as the founder of nutrition science in the United States, would become the first director of nutrition investigations for the USDA and coordinate national dietary studies. To conduct his dietary studies, Atwater also partnered with reformers who were invested in improving the conditions of the poor through nutritional education, which was particularly appealing in this era of labor unrest. The act of quantifying foods in the nutrition laboratory, and arguing for efficient food budgets with little room for pleasure or waste, lined up with the concepts of Taylorism being implemented in factories, in which workers' bodies were increasingly treated like machines.[6]

This Northeastern, urban reform context of American nutrition science has been well documented and certainly had a significant influence on the development of the science itself and its role in American society. Yet, as Myer Jaffa's lecture at the Farmers' Institute suggests, there was another setting where nutrition science was developing in the United States –the agricultural colleges and experiment stations, especially in the mid and far West. In fact, scholars have recognized that, before the First World War, the majority of nutrition research was conducted by scientists working in these settings.[7] In the early twentieth century, Naomi Aronson writes, "most American nutrition investigators worked in the agricultural experiment stations, and their work continued to be influenced by the demands of this environment."[8] Despite the large proportion of chemists working on nutrition investigations at experiment stations throughout the United States, the work of chemists outside of the Northeast is often confined to the margins in histories of nutrition science.

Using the papers of chemists investigating nutrition at the agricultural colleges and experiment stations in the mid- to far West, especially in Wisconsin and California, this dissertation examines how agricultural chemists investigated nutrition questions, framed their understanding of healthful diets, and positioned their role in relation to farmers, consumers, processors, and government in the increasingly industrial food system. My research suggests that these chemists worked in a tradition of nutrition research that often countered the more reductionist views of "pure" and industrial scientists and reformers, particularly in the Northeast. Working in an agricultural tradition of nutrition research, these chemists frequently expressed skepticism about the ability of quantitative methods alone to assess nutritional value, and pointed to the ways that their investigations challenged chemically reductionist approaches to food. They placed a value on taste, pleasure, tradition, and, more generally, food psychology in their approach to nutrition, and they expressed caution over the use of new industrially-processed foods and preservatives, due to a concern not only for their impact on the health of consumers, but also for their impact on farmers. Although, like the industrial chemists, they quantified foods in their labs and created food budgets based on nutritional standards, their approach was more flexible than that of the Yankee scientists and reformers who have been characterized as strict in their use of quantitative standards

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[6] On nutrition and Taylorism, see: Harvey A. Levenstein, *Revolution at the Table: The Transformation of the American Diet* (Berkeley: University of California Press, 1988), 81–83.
[7] See, for example: Charles E. Rosenberg, *No Other Gods: On Science and American Social Thought* (Baltimore: Johns Hopkins University Press, 1976), 186.
[8] Naomi Aronson, "Social Factors in the Development of Nutrition Studies: 1880-1920," *Journal of NAL Associates* 5, no. 1–2 (1980): 34.

in current histories of nutrition. My dissertation traces the rise and fall of the agricultural tradition of nutrition science from the Hatch Act in 1887, which established federal funding for state agricultural experiment stations, through the 1920s, when there were distinct changes in the work of these scientists and the public whom they served.

Shifting the history of nutrition science westward challenges linear narratives that focus on one strain of the science—that of the urban reformers and chemists in the Northeast—and reveals a variety of institutions, methods, geographies, and motivations that shaped the nutritional sciences. The agricultural tradition of nutrition science that developed in the Midwest and West was consequential in shaping early food regulations, in creating a paradigm shift in the science itself, and creating new types of partnerships for scientific research. Examining the work of agricultural chemists reveals alternative visions and possible trajectories for the role of science in creating a healthful food system.

I. Nutrition Science and the New Network of Agricultural Chemists in the 1880s

When Wilbur Atwater introduced the laboratory study of nutrition to the United States in the 1880s, he was working in a tradition of nutrition science from Germany, where he had studied under Carl von Voit at the Munich Physiological Institute.[9] This tradition was built on several methods for studying nutrition from a chemical standpoint that had developed over the nineteenth century in France and Germany, which included calorimetry, "balance trials," animal feeding experiments, and dietary studies. Calorimetry measured the heat output of an animal or heat of combustion of foods in calories (a calorie is unit of energy equal to raising the temperature of one gram of water by one degree Celsius).[10] While calorimetry measured energy use, "balance trials" looked at nutrient absorption by examining the chemical composition of foods consumed and comparing it to the chemical composition of excreta of a human or animal subject.[11] Chemists in the late nineteenth century measured food in ratios of proteins, fats, and carbohydrates, and were particularly interested in protein—measured through nitrogen—and nitrogen absorption.[12] In the 1860s, Voit and his colleague Max Pettenkofer developed a human respiration calorimeter that allowed them to precisely measure energy use and nutrient absorption of human subjects in various states of work and rest—a model that Atwater would use for his laboratory in the United States.[13] In 1894, another student of Voit's laboratory—German physiologist Max Rubner—used

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[9] Molly S. Laas, "Nutrition as a Social Question: 1835-1905," PhD diss., (University of Wisconsin, Madison, 2017), 24.

[10] Antoine Lavoisier developed the ice calorimeter in the later eighteenth century. Kenneth J. Carpenter, "A Short History of Nutritional Science: Part 1 (1785–1885)," *The Journal of Nutrition* 133, no. 3 (2003): 638.

[11] This type of experiment was developed by Francois Magendie in the 1810s. Carpenter, 639.

[12] Francois Magendie had conducted feeding experiments by with dogs in the early nineteenth century that demonstrated that they could not live without protein in the diet. Dogs were solely fed sugar, or olive oil, or butter, and could not live on this diet. This led Magendie to conclude: "diversity and multiplicity of ailments is an important rule of hygiene; which is, moreover, indicated to us by our instincts." Justus von Liebig declared protein the only "true nutrient" in the 1840s. Though scientists had challenged this idea by the 1880s, protein would continue to be central to the study of nutrition. Carpenter, 639.

[13] Elizabeth Neswald, "Nutritional Knowledge between the Lab and the Field: The Search for Dietary Norms in the Late Nineteenth and Early Twentieth Centuries," in *Setting Nutritional Standards: Theory, Policies, Practices*, ed. Elizabeth Neswald, Ulrike Thoms, and David F. Smith (Rochester: Boydell & Brewer, 2018), 33; Kenneth J. Carpenter, *Protein and Energy: A Study of Changing Ideas in Nutrition* (Cambridge [England]: Cambridge University Press, 1994), 70–72.

calorimeter studies with a dog to prove that the conservation of energy applied to dietetics.[14] Researchers also studied dietaries outside of the laboratory, particularly studying the diet of soldiers, prisoners, and other subjects in institutional settings.[15] Researchers in the lab and in dietary studies were interested in creating a standard for the ratio of fats, proteins, and carbohydrates needed for the diet of "the average man," and increasingly used dietary surveys to build these standards in the 1870s and 1880s.[16] In brief, when the narrative of this dissertation begins, nutrition scientists in Europe and in the United States generally defined foods and diets in terms of ratios of fats, proteins, and carbohydrates and in calories, and used a variety of methods, from calorimetry, "balance trials," animal feeding experiments, and dietary surveys, to study human dietary needs and create dietary standards. Though investigators recognized the role of minerals in food, they did not distinguish between different types of proteins nor identify vital micronutrients—or vitamins—in the diet until the early twentieth century.

Of course, the chemical approach to studying nutrition in the nineteenth century was situated in specific contexts; scientists were not confined to the laboratory, and their research was often influenced by political, social, and religious concerns. Experimenters used institutional settings like prisons, hospitals, orphanages, public kitchens, and schools as nutrition laboratories in the field, at the same time that those institutions' administrators and governments were invested in understanding dietary standards.[17] In the United States, even though there were no nutrition laboratories before Atwater's, there was scientific interest in and debates over dietary health before this period. Histories of nutrition in the United States before the 1880s most frequently examine health reform movements, particularly Sylvester Graham's vegetarian movement in the 1840s and John Harvey Kellogg's work at the Battle Creek Sanitarium beginning in the 1870s.[18] Historian Molly Laas had revealed larger debates on nutrition during this period among American scientists, physicians, and reformers, particularly as scientists created military rations and dietary plans for institutions.[19] Laas argues that scientists explicitly framed nutrition as a social question during this period, and discussed nutrition as a means of social and moral reform. She details how, before the 1880s, scientists were also overtly religious in their framing of nutrition (though, Laas argues,

[14] In other words, Rubner proved the idea of "calories in, calories out." Kenneth J. Carpenter, "A Short History of Nutritional Science: Part 2 (1885–1912)," *The Journal of Nutrition* 133, no. 4 (2003): 977.

[15] German agricultural chemist Justus von Liebig conducted one of the earliest of these dietary studies among soldiers in the 1840s. Neswald, "Nutritional Knowledge between the Lab and the Field," 32–33.

[16] Neswald, 38. In 1902, Atwater and his colleague Francis Gano Benedict proposed a 4-4-9 kcal/g ratio of fats, proteins, and carbohydrates respectively that is still used today. Carpenter, "A Short History of Nutritional Science: Part 2 (1885–1912)," 977.

[17] Neswald, "Nutritional Knowledge between the Lab and the Field," 35.

[18] Graham and Kellogg both advocated for a plain, vegetarian diet that was free of stimulants such as alcohol and coffee, and saw the modern diet as negatively impacting both the health and the morals of individuals. They argued for these diets from slightly different scientific standpoints. Graham's argument for a "natural diet" were similar to Jean-Jacques Rousseau's idea of "natural man." Graham thought the use of stimulants and meat-eating was unnatural and generally that society was corrupting. Notably, for this dissertation's second chapter, Graham also argued against commercially manufactured white bread, partially due to added chemicals. Drawing on new scientific ideas about bacteria, Kellogg thought that a diet with a high protein content from meat-eating would cause "autointoxication," or putrefaction in the intestinal tract. On Graham see: Laas, "Nutrition as a Social Question," 26. For a concise description of Graham's and Kellogg's ideas, see: Carpenter, *Protein and Energy*, 79–88. One other American experiment that is cited in histories of nutrition before the 1880 is William Beaumont's study of the stomach of a young man who had been shot. The young man continued to live for a number of years with a fistula, through which Beaumont observed how food was digested. Carpenter, "A Short History of Nutritional Science: Part 1 (1785–1885)," 643.

[19] Laas, "Nutrition as a Social Question."

even after the 1880s, religion continued to frame the thinking of scientists like Atwater, if less publicly). Though scientists in the United States were interested in nutrition before the 1880s, there was not a defined network of researchers or an institutional home for the field before Atwater began his work.

In the 1880s, Atwater not only introduced the methods of chemical laboratory research in nutrition, but also worked to establish a network of laboratories and scientists throughout the United States to conduct nutrition investigations. As historian Alan Marcus has chronicled in his foundational text, the 1870s and the 1880s marked the institutionalization of agricultural science in the United States, culminating in the Hatch Act of 1887.[20] The Hatch Act provided each state and territory funds for an agricultural experiment station that would be devoted to scientific investigation and experimentation. Before the Hatch Act, a number of state agricultural experiment stations had been established—Atwater had worked with Yale agricultural chemist Samuel Johnson to establish the Connecticut experiment station in the 1870s, and other agricultural scientists had established stations in a number of states in the 1880s. With the Hatch Act, Atwater was appointed director of the Office of Experiment Stations, and worked to coordinate researchers in stations nationally. In 1894, he won funding to coordinate investigations in human nutrition (Chapter 1).

The experiment stations were connected to state agricultural colleges that had been established or funded through the Morrill Land-Grant College Act in 1862.[21] As the name suggests, these colleges were funded through the expropriation of indigenous lands, particularly land in the West.[22] The land-grant colleges were co-educational, and offered an ideal network for research on nutrition partially because the field combined the two major disciplines of the agricultural colleges: agricultural science and domestic science.[23] Agricultural chemists at land-grant universities most often worked in animal nutrition before they began research in human nutrition, and continued to study animals alongside humans.[24] Agricultural chemists also

[20] Alan I. Marcus, *Agricultural Science and the Quest for Legitimacy: Farmers, Agricultural Colleges, and Experiment Stations, 1870-1890* (Ames, IA: Iowa State University Press, 1985).

[21] The Second Morrill Act of 1890 provided annual funding for land-grant colleges, and it withheld appropriations from states that restricted admissions by race, unless the states created separate land-grant institutions for Black students. The Second Morrill Act thus funded a number of historically Black colleges and universities, including Tuskegee University and the Hampton Institute, as described in Chapter 1. George Washington Carver would establish the first Black agricultural experiment station at Tuskegee in 1896. Linda O. Hines, "George W. Carver and the Tuskegee Agricultural Experiment Station," *Agricultural History* 53, no. 1 (1979): 71–83.

[22] Robert Lee and Tristan Ahtone, "Land-Grab Universities: Expropriated Indigenous Land Is the Foundation of the Land-Grant System," *High Country News*, March 30, 2020, https://www.hcn.org/issues/52.4/indigenous-affairs-education-land-grab-universities.

[23] In his history of agricultural education in the United States, Alfred Charles True, the second director of the Office of Experiment Stations from 1893 to 1915, described the close relationship between home economics and agricultural science. He wrote: "This closeness of relations was brought about because both branches represented the same type of education, both dealt largely with agricultural products and both depended on the same fundamental sciences for the foundations of their college course. The agricultural experiment stations were engaged in researches which bore on the problems of home economics. This was particularly true with reference to food and nutrition, bacteriology, entomology, etc. Moreover, in agriculture the work and interests of the home are indissolubly connected with those of the farm." Alfred Charles True, *A History of Agricultural Education in the United States, 1785-1925* (Washington DC: Government Printing Office, 1929), 269.

[24] Animal nutrition studies preceded those of human nutrition in both Europe and the United States. Two USDA bulletins describe this trend in short sections on the history of the science: Wilbur O. Atwater and Charles D. Woods, *Dietary Studies in New York City in 1895 and 1896* (Washington DC: Government Printing Office, 1898); Charles F. Langworthy and Robert D. Milner, *Investigations on the Nutrition of Man in the United States* (Washington DC: Government Printing Office, 1904).

frequently conducted studies in soil science and food values, and thus had broad understanding of nutrition from soil to table. Meanwhile, nutrition was a central component of domestic science, as the health and the feeding of one's family was a significant domestic responsibility. Nutrition research provided an opportunity for women with degrees in chemistry to conduct laboratory research through the discipline of domestic science; chemist Ellen Richards began working in this field particularly through "nutrition education" at MIT in the 1889.[25] When Isabel Bevier studied chemistry under Professor Albert Smith at the Pennsylvania College of Women in the 1880s, Smith prophesized: "The field for women in chemistry is in work in food and I believe the day will come when the large Mid-west universities, Michigan, Wisconsin, and Illinois, will have departments in the chemistry of foods or something of that kind, and you'd better prepare for it."[26] The land-grant universities across the United States provided the institutional homes for a network of scientists across disciplines interested in nutrition research.

The Hatch Act was partially a response to agrarian movements gaining strength across the country from the 1870s to the 1890s. During this period, farmers mobilized politically in the face of a number of new challenges, including "burdensome debt, crippling deflation, low and unstable crop prices, monopolistic railroads, exploitative wholesalers, political disempowerment, and cultural disrespect."[27] The agrarian response to these issues gave rise to the Grange in the 1870s and the Farmers' Alliance in the 1880s and 1890s. These groups created the national People's (or Populist) Party in 1892. Though past scholars have emphasized an antagonistic relationship between academics and Populists, recent scholarship has instead highlighted how agrarian organizations worked with and shaped land grant colleges.[28] Charles Postel, for example, describes how Farmers' Alliances "lobbied long and hard to ensure that the land-grant colleges remained true to their original mission as centers for agricultural research and expertise. They demanded that colleges provide more access to farmers, and offer courses and build facilities more relevant to the business and scientific needs of future agriculturalists."[29] As Nathan Sorber has argued, in the late 1880s farming organizations like the Grange and the Farmers' Alliances sought to reform the land-grant colleges to better address the needs of farmers, and land-grant colleges

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[25]For work on women chemists in nutrition during this period, see: Maresi Nerad, *The Academic Kitchen: A Social History of Gender Stratification at the University of California, Berkeley* (State University of New York Press, 1999); Rima D. Apple, "Science Gendered: Nutrition in the United States, 1840-1940," in *The Science and Culture of Nutrition, 1840-1940*, ed. Harmke Kamminga and Andrew Cunningham, vol. 32 (Amsterdam-Atlanta, GA: Rodopi, 1995), 129–54; Margaret W. Rossiter, "'Women's Work' in Science, 1880-1910," *Isis* 71, no. 3 (1980): 381–98.

[26]Quoted in: Beverly Bartow, "Isabel Bevier at the University of Illinois and the Home Economics Movement," *Journal of the Illinois State Historical Society (1908-1984)* 72, no. 1 (1979): 25. It is worth noting that "work in food" was not always the field that women in chemistry wanted to pursue. In 1896, while working at the Pennsylvania College for Women, Bevier wrote to Atwater asking if he knew of any job openings in chemistry. In a subsequent letter, she wrote that she hoped for a new opportunity "so that 'sometime' I may be fitted to more advanced work. While I am much interested in the dietary work it seems to me I should prefer work more distinctly chemical. I can not quite give up the idea of getting, sometime and somehow, an equivalent for post-graduate work in chemistry which I was hindered from doing." Isabel Bevier to Wilbur Atwater, April 14, 1896, Wilbur Olin Atwater papers, #2223. Division of Rare and Manuscript Collections, Cornell University Library (Hereafter, Atwater Papers, Cornell).

[27] Scott M. Gelber, *The University and the People: Envisioning American Higher Education in an Era of Populist Protest* (Madison: University of Wisconsin Press, 2011), 10.

[28] Scott Gelber argues in his history of "academic populism" that earlier scholarship that emphasizes the tension between these groups was often working in the narrative of populism put forth in Richard Hofstadter's *Age of Reform* (1955), which depicted populists as anti-science, backwards, and bigoted. Charles Postel's more recent assessment of populism—*The Populist Vision* (2007)—challenges this depiction. Gelber's and Nathan Sorber's work revise the relationship between populists and land-grants from this new viewpoint on the movement. Gelber, 5-8.

[29] Postel, *The Populist Vision*, 54.

responded by providing more agricultural education and outreach, including programs like the farmers' institutes.[30] This is not to say that there was not conflict between agrarian organizations and agricultural scientists during this time—Scott Gelber describes a "tense, yet productive, relationship between public pressure and academic authority"—but it is to say that land-grant scientists in the 1880s through the early 1900s were under pressure to frame their publicly-funded scientific work as serving their state's farmers.[31]

In the late nineteenth and early twentieth century, this connection of farmers to agricultural scientists may have been particularly pronounced in two states that are prominent in this dissertation—Wisconsin and California. Wisconsin and California have both been noted for the way that their powerful agricultural constituencies shaped the history of their state politics.[32] In the early twentieth century, Wisconsin is particularly well-known for its strong agrarian and progressive politics—this can be seen in the figure of the progressive Robert "Fighting Bob" La Follette and the famous "Wisconsin Idea," which connected the university to the state government with a mission of serving the people.[33] Recent work by Michael Lansing also points to the mix of agrarianism and progressivism in North Dakota's politics at this time.[34] Notably, Edwin Ladd—an agricultural chemist who worked on nutrition and the first director of the North Dakota Experiment Station, who plays a prominent role in Chapter 2—would be elected to the U.S. Senate in 1920 with the backing of the Nonpartisan League, an agrarian political organization.[35] In the late nineteenth and into the early twentieth century, agricultural chemists across the United States were pressured to demonstrate they were serving their state's farmers, but perhaps even more so in the states that I examine. This pressure tied the work of these land-grant agricultural chemists to their state's agricultural landscape.

Shifting the focus of the history of nutrition science from urban reform to agricultural colleges and experiment stations thus situates the development of the science in broader changes in the food system. The agrarian movements were partially responding to a dramatic transformation taking place in the American and global food system during this period. In the United States, westward expansion, increased urbanization and industrialization, and technological developments in the mid-nineteenth century, including refrigerated railcars, steam-powered grain elevators, food processing factories, mechanized slaughterhouses, and industrial feedlots, along with advancements in agricultural science, from plant breeding to pesticides to chemical fertilizers, brought the far reaches of the United States into a national and global food market. As farmers

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[30] Sorber looks specifically at the land-grant colleges in the Northeast, though he says they represent broader trends. Between 1887 and 1893, in the Northeast, the Grange worked to use the Morrill funds to establish new institutions in Connecticut, New Hampshire, and Rhode Island, and to reform existing institutions in Maine, Pennsylvania and New York. Sorber argues that this was a response to outmigration and agricultural depression over the 1870s and 1880s. Nathan M Sorber, *Land-Grant Colleges and Popular Revolt: The Origins of the Morrill Act and the Reform of Higher Education* (Ithaca, NY: Cornell University Press, 2018).

[31] Gelber, *The University and the People*, 9.

[32] E. Melanie Dupuis, for example, has noted how these powerful agricultural groups shaped the politics of milk regulation in the 1920s and 1930s in California and Wisconsin, which created what she calls "producerist" policies, while in New York, the politics was shaped by consumers and created "productivist" policies. E. Melanie DuPuis, *Nature's Perfect Food: How Milk Became America's Drink* (NYU Press, 2002), 183–209.

[33] Nancy C. Unger, *Fighting Bob La Follette: The Righteous Reformer* (Chapel Hill: University of North Carolina Press, 2000). La Follette served Wisconsin as a U.S. Representative from 1885-1891, State Governor from 1901-1906, and U.S. Senator from 1906-1925.

[34] Michael Lansing, *Insurgent Democracy: The Nonpartisan League in North American Politics* (Chicago: University of Chicago Press, 2015).

[35] Lansing, 227.

contended with the rise of industrial middlemen—such as railroads, banks, and food processors—an increasingly urban population was also presented with a new diverse array of food choices. For the first time, Americans across the United States could eat fresh fruit from California, butter from Wisconsin, or Texas-raised beef slaughtered in Chicago, along with a host of new processed foods, from Post's Grape-nuts, Heinz ketchup, to Campbell's canned soup.[36] As this dissertation will examine, agricultural chemists studying nutrition took on a unique new role of mediating the relationship between farmers, processors, and consumers in this industrializing food system.

The role of the chemist as mediator between farmers and manufacturers was a part of the earliest work of the agricultural experiment stations, as agrarian groups called for their state governments to hire chemists to regulate commercial fertilizers. In the 1870s and 1880s, farmers complained that commercial fertilizer companies were making fraudulent claims that did not produce the advertised results, and agrarian organizations began hiring chemists and lobbying for a state chemist to analyze and regulate the commercial products through agricultural experiment stations. Commercial fertilizer manufacturers, meanwhile, also began hiring their own chemists to dispute the accusations of the state chemists. In 1884, the state chemists organized themselves in the Association of Official Agricultural Chemists (AOAC), which established standards for analysis of fertilizers, and they excluded manufacturing chemists from joining the association.[37]

The AOAC was notably organized by the head of the new division of chemistry for the USDA—Harvey Wiley—who had previously been the state chemist in Indiana. In 1886, as president of the AOAC, Wiley proposed that the organization expand their role to include analyzing adulteration in foodstuffs, and the next year, his division began publishing segments of a well-known bulletin on food adulteration for the USDA (Bulletin 13).[38] This movement would grow into the campaign for the Pure Food and Drug Act of 1906. A number of the agricultural chemists who worked on nutrition investigations under the direction of Wilbur Atwater in the 1890s (Chapter 1) were a part of the AOAC and also worked with Wiley to campaign for state food and drug laws (Chapter 2).[39] Often these two lines of work—nutrition investigations and food adulteration—are examined separately in historiography, but these fields overlapped in personnel and in their research questions. Indeed, the lines of inquiry in these two areas, one on how to assess the nutritional value of a food and diet, and the other how to distinguish healthful from harmful food products and additives—were clearly interrelated. This dissertation examines the ideas agricultural chemists presented in their nutrition investigations as well as in their arguments for pure food to understand their vision for nutrition science.

Atwater's introduction of laboratory work in nutrition, the creation of domestic science departments and Ellen Richards' work at MIT, and Wiley's organization of the AOAC and Bulletin 13 are familiar origin stories to those working in the history of nutrition science in the United

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[36] William Cronon describes this process of creating a national food system centered in the railroad hub of Chicago, connected farmers and ranchers in the West to consumers in the East. William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W.W. Norton, 1992). For the rise of food processors, see: Levenstein, *Revolution at the Table*, 30–43.

[37] Marcus, *Agricultural Science and the Quest for Legitimacy*, 42–58.

[38] Marcus, 42–58; Benjamin R. Cohen, *Pure Adulteration: Cheating on Nature in the Age of Manufactured Food* (Chicago: The University of Chicago Press, 2019), 206–9.

[39] Myer Jaffa, Edwin Ladd, and Winthrop Stone all conducted nutrition investigations with Atwater, were members of the AOAC, and campaigned for pure food and drug laws. Jonathan Rees, in his study of Harvey Wiley, quotes Winthrop Stone to show how Harvey Wiley's tactics influenced agricultural chemists. Stone stated that "nearly every article of food was systematically adulterated" and that "most all green goods were covered with poisonous metals." Jonathan Rees, *The Chemistry of Fear: Harvey Wiley's Fight for Pure Food* (Baltimore: Johns Hopkins University Press, 2021), 70.

States. I propose that there was another scientific institution from the 1880s that was fundamental to origin and development of nutrition science in the United States—the Geneva Experiment Station in New York. Alan Marcus claims that this station—and its director, E. Lewis Sturtevant—played a more influential role in the direction of agricultural experiment stations nationally than the Connecticut station under Wilbur Atwater.[40] In the early 1880s, while Atwater and Johnson's Connecticut station largely focused on analyzing chemical fertilizers, Sturtevant organized the Geneva Station to conduct original experiments by workers in a number of scientific disciplines who would study different aspects of a single inquiry.[41] In the late 1880s, established experiment stations—including Atwater's—and new stations adjusted their research agendas using Sturtevant's station as model.[42]

Two chemists who play important roles in this dissertation started their careers at the Geneva station in 1880s: Stephen M. Babcock, who later designed a groundbreaking experiment at the University of Wisconsin (Chapter 3), was an analytical chemist for the station beginning at its founding in 1882, and Edwin Ladd, who would be a leader in the pure food movement while working at the agricultural experiment station in North Dakota (Chapter 2), worked as Babcock's assistant beginning in 1884 (Figure 2).[43] At the Geneva station, Babcock noticed that an analysis of animal feces appeared to have the same nutritional content of food, making him seriously question the ability of the contemporary processes of chemical analysis to assess the nutritional value of food (Chapter 3). Charles Plumb, who was the first assistant of the Geneva station, seems to have referenced this at a meeting of the Association of American Agricultural Colleges and Experiment Stations in 1890. "Mr. Plumb said that in digestion experiments conducted at his station a higher percentage of nutriment was found in the dung than had been put into the animal. Those who had large experience in this line were skeptical in regard to the results obtained."[44] Even though Babcock did not publish on this observation, Plumb's comment shows that Babcock's criticism was repeated years later. Edwin Ladd and Stephen Babcock are not usually discussed together in histories of nutrition science, but as this dissertation will show, Ladd's criticisms of new industrialized, processed foods were similar to Babcock's criticisms of the reductionist, calorimetric paradigm of the science. Both Babcock and Ladd left the Geneva station for experiment stations in the Midwest when the Geneva station was under intense criticism from farmers for not producing practical results in the late 1880s.[45]

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[40] Marcus, *Agricultural Science and the Quest for Legitimacy*, 103.
[41] Marcus, 92–103.
[42] Marcus, 103.
[43] Paul Jones Chapman, Edward Hadley Glass, and Roscoe E Krauss, *The First 100 Years of the New York State Agricultural Experiment Station at Geneva, NY* (New York State Agricultural Experiment Station, 1999), 11,15; R. James Kane, "Populism, Progressivism, and Pure Food," *Agricultural History* 38, no. 3 (July 1964): 162.
[44] A.W. Harris and H.E. Alvord, eds., *Proceedings of the Fourth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations Held at Champaign, Illinois, November 11, 12, and 13, 1890* (Washington DC: Government Printing Office, 1891), 91. Rosenberg notes Plumb's remark parenthetically in *No Other Gods.* He writes: "Some nutrition workers did entertain a healthy skepticism toward these conventional ratios. C.S. Plumb, for example, remarked in 1890 that he had found a higher complement of nutrient—calculated according to the accepted doctrine—in the feces of experimental animals than in the food they had consumed." Rosenberg, *No Other Gods*, 201. Shortly after Plumb's comment, at that same meeting, an unidentified member "asked what was the effect of long-continued feeding on a single article of diet, perhaps not a very palatable one, as compared with that of feeding the same article in combination." There is no indication of who this member was, but this small comment captures the initial idea of Babcock's groundbreaking "Single-Grain Experiment," which would lead to pioneering work on vitamins (the subject of Chapter 3).
[45] Babcock went to the University Wisconsin, where he continued the experiments started at the station that led to his widely used Babcock milkfat test. He reportedly advised Ladd to look west for work in chemistry as well, mirroring

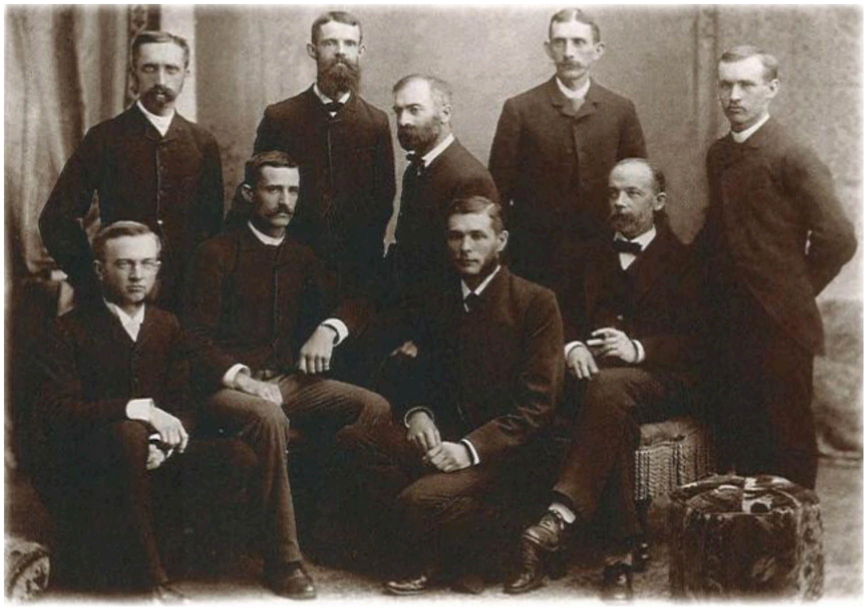

Figure 2: "The [Geneva Experiment] Station staff of 1886. Seated left to right: F.E. Newton, stenographer; C.S. Plumb, first assistant; S.M. Babcock, chemist; M.H. Beckwith, assistant horticulturist; and E. Lewis Sturtevant, director. Standing, left to right, J.C. Arthur, botanist; E.S. Goff, horticulturist; C.W. Churchill, farmer; and E.F. Ladd, chemist." At the Geneva Experiment Station, Babcock raised critical questions about the ability of chemical analysis to measure nutritional value of food, questions that became the base of the pioneering experiments in vitamin research at the University of Wisconsin. Ladd worked as Babcock's assistant at the Geneva Station, and would become a vocal advocate for the pure food and drug law in North Dakota. Chapman, Paul Jones, Edward Hadley Glass, and Roscoe E Krauss. *The First 100 Years of the New York State Agricultural Experiment Station at Geneva, NY*. New York State Agricultural Experiment Station, 1999, 15.

The connection of scientists at agricultural colleges and experiment stations to serving farmers may be one of the reasons why these scientists often play a marginal role in histories of nutrition science. In these histories, these chemists are often defined as "applied scientists." "Their analysis of feeding stuffs and agricultural products," as Charles Rosenberg has put it, "was not motivated by a concern for some ultimate physiological truth but was dictated and supported by the economic needs and political power of agriculture."[46] Yet, many chemists at experiment stations *were* interested in fundamental questions and basic research, even as they framed their studies as serving farmers. Agricultural chemist Winthrop Stone of Purdue University declared in 1895: "The intensely practical persons who fill the public eye, who invest and apply and practice are only able to do so because the truths and principles of pure science underlying their practical

the advice given to Isabel Bevier that the place for work in food chemistry was in the West. Chapman, Glass, and Krauss, *The First 100 Years of the New York State Agricultural Experiment Station at Geneva, NY*, 16; Alfred C. Melby, "A Chemist in the Senate: Edwin Fremont Ladd, 1921-1925" (PhD diss., University of North Dakota, 1967), 3, https://commons.und.edu/theses/1132.

[46] Rosenberg, *No Other Gods*, 201. Levenstein similarly divides "pure" and "applied" research in home economics during this time as a divide between the Northeast and the West. He writes that the scientific home economists of the Northeast studied nutrition, while "In the Midwest and West, the domestic science courses of the land-grant colleges and universities were expected to teach future farmers' wives cooking and housekeeping." He writes that the western domestic scientists did activities like teaching canning at farmers' institutes instead of studying "the latest theories about the metabolism of protein." Levenstein, *Revolution at the Table*, 77.

matters have already been worked over by someone else."[47] In a plea for more research funding, Myer Jaffa wrote in 1910, "It does not appear that a laboratory […] located in the Department of Nutrition of the University, is doing its best work if original investigations in nutrition are not being conducted."[48] Historian Rima Apple also notes that before the 1920s, Harry Steenbock, the researcher who conducted groundbreaking work on vitamin D (Chapter 5) at the University of Wisconsin, "clearly sought to establish himself as a researcher and to eschew the role of applied scientist."[49] These scientists consistently had to balance serving farmers and conducting fundamental research, and their work demonstrates how the line between applied and basic research is blurry.[50] "Original research" was and continued to be an important component of the work of chemists at agricultural colleges and experiment stations, even as they connected their work to serving their state's farmers.[51]

II. Historiography of Nutrition Science in the United States

Historical scholarship on nutrition science in the United States during this period tends to fall into three categories: The first and earliest histories of the field are internalist histories, often written by scientist-historians who narrate the history as a series of discoveries made by "pure" scientists. These histories offer linear narratives tracking the advancement of knowledge from one great discovery to the next, and, at their best, they provide their readers with an understanding of the sequence of major investigations, frameworks, and concepts in the science and their associated researchers.[52] As a linear sequence of great discoveries, they tend to pay little attention to precursors to discoveries or to alternative traditions of the science, and so the nutrition work at the agricultural colleges and experiment stations plays a small role before 1920. One scientist at an agricultural college who *is* frequently included in these histories is Elmer McCollum, who is often associated with the discovery of vitamins—but McCollum is usually framed as an exceptional individual, and more often associated with Johns Hopkins (where he spent most of his career) than the University of Wisconsin (where he began his work in nutrition).[53] Interestingly enough, McCollum was also one of the earliest scientist-historians of nutrition science, and his histories of

[47] "Addresses, etc. 1895," Box 27, Winthrop Stone Papers, Purdue University Archives and Special Collections, Purdue University Libraries, West Lafayette, Indiana. (Hereafter, Winthrop Stone Papers).
[48] Quoted in Patricia B. Swan and Kenneth J. Carpenter, "Myer E. Jaffa: Pioneering Chemist in the Food and Nutrition Sciences," *Bull. Hist. Chem* 21 (1998): 54.
[49] Rima D. Apple, "Patenting University Research: Harry Steenbock and the Wisconsin Alumni Research Foundation," *Isis* 80, no. 3 (1989): 387.
[50] Marcus discusses this balance throughout his foundational work on agricultural science in the United States. Marcus, *Agricultural Science and the Quest for Legitimacy*.
[51] The Adams Act in 1906 increased the appropriations for research funding in the Hatch Act, but specified that the funding was for "original research." The Smith-Lever Act of 1914 designated funding for extension service agents, shifting outreach responsibilities away from scientists. This did not mean scientists no longer spoke to farmers; Newspapers reported Myer Jaffa, for example, giving lectures in various farming communities in the 1920s: "Prof. Jaffa Will Speak at Fig Institute," *Merced Sun-Star* (Merced, CA), January 7, 1923; "Nothing New Under the Sun," *Madera Tribune* (Madera, CA), November 7, 1925, California Digital Newspaper Collection.
[52] Kenneth Carpenter's work is particularly useful for understanding a broad overview of major nutrition experiments. Carpenter, *Protein and Energy*.
[53] Notably, Levenstein writes that McCollum conducted his research at Yale in error, and it appears that at least one other scholar, Gyorgy Scrinis, repeated this error. Levenstein, *Revolution at the Table*, 148; Gyorgy Scrinis, *Nutritionism: The Science and Politics of Dietary Advice* (New York: Columbia University Press, 2013), 64.

the science continue to be cited.[54] McCollum was invested in making his own priority claim to the discovery of vitamins, so he downplayed precursors to vitamin research, including the interest of agricultural chemists in pure research.[55] Scholars building from McCollum's early histories of the science, and then scholars building from those histories, seem to have repeated McCollum's claims.

The second, and the largest, category of historical scholarship on nutrition science are social histories that are more broadly interested in the history of dietary advice and scientism in the United States. Most of these histories are indebted to Harvey Levenstein's foundational and sweeping history, *A Revolution at the Table*, published in 1988, which traces the material, social, and ideological changes that led to the "the transformation of the American diet" from 1880 to 1930.[56] In his narrative, which covers a wide range of transformations from the food industry to the home table, nutrition science is largely employed as a means of social control—to critique the food choices of the working class or immigrants—and as a partner of large, industrial food processors. In discussing the science, Levenstein focuses on "pure" scientists and home economists—as well as faddists and reformers who employed the authority of science—and he is often critical of scientists who were wrong in their nutritional claims.[57] Recent scholars—most prominently E. Melanie Dupuis, Charlotte Biltekoff, and Helen Zoe Veit—have continued this line of argument that nutrition was primarily a means of social control, and they, too, frequently criticize when nutrition scientists in the past were wrong. This recent scholarship is particularly interested in the morals embedded in the science; the way that ideas of "good" and "bad" eating were shaped by and shaped class, gender, and race identities and ideas of citizenship.[58]

[54] For an example of recent scholarship that uses McCollum's work, see: Scrinis, *Nutritionism*, 54, 61; Hamilton Cravens, "The German-American Science of Racial Nutrition, 1870-1920," *Technical Knowledge in American Culture: Science, Technology, and Medicine since the Early 1800s*, 1996, 125–45. Charles Rosenberg also primarily relied on McCollum's history in his examination of the discovery of vitamins, and Naomi Aronson pointed to the issues of Rosenberg's use of McCollum as a source. I discuss this in Chapter 3. Rosenberg, *No Other Gods*, 200–210; Naomi Aronson, "The Discovery of Resistance Historical Accounts and Scientific Careers," *Isis* 77, no. 4 (1986): 630–46. Levenstein primarily relies on McCollum's history in discussing the discovery of vitamins, which McCollum wrote ushered in "the Newer Knowledge of Nutrition"—the title of one of McCollum's histories, and a phrase other historians have adopted to discuss the paradigm shift. Levenstein, *Revolution at the Table*, 147–49. For an example of scholarship that then builds on Levenstein's work, see: Charlotte Biltekoff, *Eating Right in America: The Cultural Politics of Food and Health* (Durham, NC: Duke University Press, 2013), 46–47; Helen Zoe Veit, *Modern Food, Moral Food: Self-Control, Science, and the Rise of Modern American Eating in the Early Twentieth Century* (Chapel Hill: University of North Carolina Press, 2013), 47–48.

[55] In *A History of Nutrition* (1957), for example, he makes no mention of the University of Wisconsin and implies that he and his coinvestigator (Davis) invented the "biological method of research" entirely on their own (220). McCollum had a strained relationship with the scientists at the University of Wisconsin, which might have also contributed to him excluding them from his history of the discovery of vitamins. I discuss this in Chapter 3. Elmer Verner McCollum, *A History of Nutrition; the Sequence of Ideas in Nutrition Investigations* (Boston: Houghton Mifflin Company, 1957). Elmer Verner McCollum, *The Newer Knowledge of Nutrition: The Use of Food for the Preservation of Vitality and Health* (Macmillan, 1922).

[56] Levenstein, *Revolution at the Table*.

[57] For example, in discussing Harvey Wiley's work in the Pure Food Movement, Levenstein only discusses the way that the law in fact helped large food processors and how Wiley partnered with Heinz to secure its passage (39-40); in discussing Atwater's work, he emphasizes his partnership with reformers and how it was used to critique the working class (44-48); and points out that Atwater did not recognize the value of fruits and vegetables before the discovery of vitamins (57). Levenstein.

[58] Veit, *Modern Food, Moral Food*; Biltekoff, *Eating Right in America*; E. Melanie DuPuis, "Angels and Vegetables: A Brief History of Food Advice in America," *Gastronomica: The Journal of Food and Culture* 7, no. 3 (August 1, 2007): 34–44; E. Melanie DuPuis, *Dangerous Digestion: The Politics of American Dietary Advice* (Berkeley: University of California Press, 2015); Julie Guthman, *Weighing in: Obesity, Food Justice, and the Limits of Capitalism*

Part of this category of scholarship is scholarship that more closely traces the history of nutrition science as a history of quantitative reductionism, most prominently the scholarship by philosopher Gryorgy Scrinis and science communications scholar Jessica Mudry. Scrinis coined the term "nutritionism" to describe the quantitative, reductionist approach to nutrition that simply assesses the health value of food based on nutrients without considering taste, culture, tradition, or food production. He argues that this ideology and paradigm is rooted in the work of Wilbur Atwater and his calorimeter in the late nineteenth century and continues to be the dominant framework for understanding dietary health today.[59] Jessica Mudry also traces the use of a reductionist, quantitative approach to understanding nutrition from Wilbur Atwater through the twentieth century, focusing on government-produced dietary guidelines.[60] Both of these scholars are critical of the nutritionism paradigm and attribute it to issues in dietary health today. They are most interested in the latter half of the twentieth century to the present day, and so they take a teleological approach to the earlier era, tracing a linear history of rising reductionism that eventually leads to the dietary problems today. They thus do not account for debates within the science, alternative approaches to the science, and alternative possible trajectories for the science before the mid-twentieth century. This reductionism is often a part of the criticisms of the scholars discussed above, who examine how this quantitative reductionism was used in social control and embedded with moralism.

Notably, the scholars working in this second category examine the work of trained scientists alongside reformers and/or food faddists, and frequently conflate these groups under a general term like "nutritionist" or "nutrition-expert."[61] They seem most interested in how a scientific-reductionist approach to food has been mobilized and popularized to various ends, thus their "nutrition-experts" tend to be pure scientists and urban reformers in the Northeast who employed a reductionist view of nutrition. These scholars are not interested in debates or alternative approaches within the scientific field, and so the nutrition work taking place at the agricultural colleges and experiment stations across the country generally plays little to no role until Elmer McCollum's work on vitamins.[62] Though this scholarship is useful for understanding how scientific reductionism was employed in dietary reform efforts, it is problematic for understanding the development of the science itself. It tends to characterize scientists as having the same reductionist perspective employed by reformers and faddists, thus it seems to buy into the claims of food faddists and reformers that they were nutrition experts.[63] Though faddists would

(Berkeley: University of California Press, 2011); John Coveney, *Food, Morals, and Meaning: The Pleasure and Anxiety of Eating* (London: Routledge, 2000); Chin Jou, "Controlling Consumption: The Origins of Modern American Ideas about Food, Eating, and Fat, 1886-1930" (PhD diss., Princeton University, 2009); Cravens, "The German-American Science of Racial Nutrition, 1870-1920."

[59] Scrinis, *Nutritionism*.

[60] Jessica J. Mudry, *Measured Meals: Nutrition in America* (Albany, NY: Suny Press, 2009).

[61] Some scholars, including Gyorgy Scrinis and Chin Jou, explicitly say that the "nutrition experts" (Scrinis) or "nutrition authorities" (Jou) whom they examine do not include faddists. Others, like E. Melanie Dupuis and Helen Zoe Veit, explicitly include faddists as a part of their examination of nutrition science (Veit) or discussion of "writer-experts" or "expert-reformers" (Dupuis). Edward Atkinson, a reformer with no scientific training, for example, is often discussed as a "nutrition-expert" or colleague of Atwater (See, for example, Coveney, 77). Coveney, *Food, Morals, and Meaning*. Scrinis, *Nutritionism*, 23; Jou, "Controlling Consumption," 7; Veit, *Modern Food, Moral Food*, 40; DuPuis, *Dangerous Digestion*, 80–81.

[62] Often, in this category of literature, McCollum's work on vitamins is discussed to note the paradigm shift in the science, without a discussion of the broader context of his research. Dupuis is an exception to this – she notes the influence of the dairy industry on research at the University of Wisconsin: DuPuis, *Dangerous Digestion*, 91.

[63] Perhaps most famously, Horace Fletcher--known for his mastication fad--was consistently called a scientist and physician, including in his obituary in the *New York Times*, because he ascribed these labels to himself and described

draw on the authority of science, scientists often positioned themselves in direct opposition to food faddists. Reformers played a significant role in popularizing scientific ideas about nutrition, but they shaped these ideas to fit their agendas –whether the Americanization of recent immigrants or teaching food economy to the poor.[64]

This dissertation does not focus on the history of dietary advice, but instead focuses on the work and ideas of agricultural chemists as they developed the science at land-grant colleges and experiment stations outside of the Northeast. I have found that, perhaps counterintuitively, the chemists I examined had a more holistic approach to nutrition than the "nutrition-experts"—scientists, reformers, and faddists—so often discussed in the current scholarship. For reasons of time and space, this dissertation also does not focus on the work of home economists, who played a vital role in establishing the field of nutrition science. These scientists—often women chemists trained alongside men in the same laboratories where the agricultural scientists trained—likely also had a more holistic approach to nutrition than the approach used to characterize them in the scholarship, as shown in my examination of the dietary studies conducted by domestic scientist Isabel Bevier (Chapters 1 and 3). My claim is not that the agricultural tradition was the only tradition or that it was more important than the nutrition research taking place in home economics departments or "pure" laboratories, but to claim that it was a significant tradition in the nutritional sciences—both politically and scientifically—that has been overlooked in the current scholarship.

There is a third category of scholarship on the history of nutrition science in the United States: social histories of the science, that examine the development of the field and the work of scientists in their institutional, historical, and social contexts. These historians might examine broader changes in the food system and reform movements, but, unlike the above scholarship, they are more interested in how these contexts shaped the field than in how the field was popularized, and generally their aim is not to explain health issues today.[65] Prominent in early works in this category is scholarship by Naomi Aronson and Charles Rosenberg. In her work, Aronson variously examines how institutions, funding, and disciplinary and priority concerns shaped the work of scientists.[66] Though frequently cited by scholars above and associated with the "nutrition as social control" thesis, Aronson was critical of a "top-down" view of the history of nutrition science and instead examined how the broader social context shaped how scientists framed their work.[67] Charles Rosenberg also examines the impact of the institutional context on the science,

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famous nutrition scientists as his colleagues. Margaret Barnett writes: "In fact, Fletcher had never studied medicine anywhere and had not graduated from any university. His relationship with [four physiologists that he described as colleagues] was that of a test subject rather than a pupil, in experiments that he himself, in some cases, funded." Barnett, "The Impact of" Fletcherism" on the Food Policies of Herbert Hoover during World War I," 239–40.

[64] See the conflict between Atwater and Atkinson in Chapter 1, or the discussion of faddism in Chapter 4.

[65] The distinction between the second two categories of scholarship is subtle, and in fact, often people categorize them as working in the same tradition. I think these is a small but significant difference, however, between the scholars who are focused on dietary advice, moralism, and nutritionism and scholars interested in the history of the scientific field. Part of the difference is the end point –scholars in the first category are often interested in explaining the roots of the present-day reductionism and nutrition issues. Scholars in this latter category do defend their examination of faddists and reformers as well as scientists in a similar way to the social-control scholars, but they are more interested in co-production of scientific knowledge than in a top-down view of reductionism and social control. See, for example: Elizabeth Neswald, David F. Smith, and Ulrike Thoms, *Setting Nutritional Standards: Theory, Policies, Practices* (Rochester: Boydell & Brewer, 2017), 4.

[66] Aronson, "Social Factors in the Development of Nutrition Studies: 1880-1920"; Naomi Aronson, "Nutrition as a Social Problem: A Case Study of Entrepreneurial Strategy in Science," *Social Problems* 29, no. 5 (1982): 474–87; Aronson, "The Discovery of Resistance."

[67] In reviewing Bryan Turner's *The Government of the Body*, Aronson wrote: "To suggest that the growth of nutrition science was a simple top down process of social control is misleading. The goals of nutrition scientists and poverty

and is close to discussing the agricultural tradition of nutrition science that I examine in this dissertation in his discussion of Elmer McCollum's work in vitamins at the University of Wisconsin. Rosenberg writes that there was a "tradition of practical nutrition work" at agricultural colleges and experiment stations, but, working from McCollum's histories, he adopts the idea that agricultural scientists—aside from McCollum—were uninterested in fundamental research questions.[68] Also working in this category, Rima Apple analyzes the broader institutional, political, and social forces that shaped work on vitamins at the University of Wisconsin and work on nutrition by home economists.[69] This dissertation builds on the work of these scholars and others in this category even as it makes different points.

In this category is an emerging body of scholarship—which this dissertation joins—that directly challenges the reductionist characterization and linear histories of nutrition science from the mid nineteenth to the early twentieth centuries. Harmke Kamminga, for example, argues that Dutch physiologist Jacob Moleschott had a radically different vision for nutrition science than his contemporary in the mid-nineteenth century, Justus von Liebig. Moleschott used a more holistic approach to studying nutrition and engaged in social questions, believing that "the scientist should always have one foot in the laboratory and one foot in the world at large," Kamminga writes.[70] Kamminga suggests that Moleschott has been excluded from the historiography of nutrition science because "the history of nutrition has, by and large, been written by nutrition scientists [and thus] bound inextricably with the establishment of a separate science of nutrition: that the making of the history of nutrition science was part and parcel of the making of the science of nutrition itself." In writing this history, scientist-historians have excluded "the explicitly value-laden bits" from their histories, Kamminga argues.[71] Most recently, Elizabeth Neswald, David M. Smith, and Ulrike Thoms in the introduction to their edited volume, and Molly Laas in her dissertation, have explicitly challenged the narrative of quantitative reductionism put forth by Scrinis and Mudry.[72] Laas reassesses Wilbur Atwater's work and engagement with nutrition as a social question, and suggests that he was less reductionist than how he is usually portrayed. Laas suggests that there was "not one nutrition science in the late nineteenth century, but instead several nutrition sciences, developed by different scientists to varied ends."[73] Looking at the chemists at agricultural colleges and experiment stations outside of the Northeast, this dissertation supports this idea that there were "several nutrition sciences," not only in the late nineteenth century, but through to the 1920s.

Chemists working in the agricultural tradition of nutrition science had a vision for the science that contended with the reductionist view of many "pure" scientists and reformers in the Northeast. This vision was skeptical of a purely chemical approach to food, of the health impact

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analysts converged at some times, conflicted at others. The workers who were 'the objects of scientific practice' resisted; some refused to allow nutrition researchers into their communities, others engaged in public debates with proponents of scientific eating" (63). Naomi Aronson, "Comment on Bryan Turner's 'The Government of the Body: Medical Regimens and the Rationalization of Diet,'" *The British Journal of Sociology* 35, no. 1 (1984): 62–65.

[68] Rosenberg, *No Other Gods*, 190. See also: Charles E. Rosenberg, "On the Study of American Biology and Medicine: Some Justifications," *Bulletin of the History of Medicine* 38, no. 4 (1964): 364–76.

[69] Apple, "Patenting University Research"; Rima D. Apple, *Vitamania: Vitamins in American Culture* (New Brunswick, NJ: Rutgers University Press, 1996); Apple, "Science Gendered."

[70] Harmke Kamminga, "Nutrition for the People, or the Fate of Jacob Moleschott's Contest for a Humanist Science," in *The Science and Culture of Nutrition, 1840-1940* (Amsterdam-Atlanta, GA: Rodopi, 1995), 15–47.

[71] Kamminga, 38. Notably, Kamminga cites Elmer McCollum's histories of nutrition as her main example of work that has excluded Moleschott.

[72] Laas, "Nutrition as a Social Question," 14–16; Neswald, Smith, and Thoms, *Setting Nutritional Standards*, 3–5.

[73] Laas, "Nutrition as a Social Question," 170.

of new processed foods, and of the social impact of new food corporations. Agricultural chemists studying human nutrition were allied with their state's farmers and positioned themselves as mediators between farmers, processors, and consumers in the newly industrializing food system. Their alternative view of human nutrition was consequential politically - in the passage of the Pure Food and Drug Act in 1906 - and scientifically - as their skepticism provided the roots for pioneering vitamin experiments in the United States. Yet this alternative tradition declined. My dissertation suggests that in the 1920s, changes in the farming landscape, in the funding of scientific research, and in the methods and subjects of nutrition research allowed for the more reductionist, purely chemical approach to nutrition to become synonymous with the science.

III. Outline of the Dissertation and Research

My dissertation traces the development of the agricultural tradition of nutrition science through five significant events in nutrition science in the United States from the 1880s to the 1920s. While the dissertation moves roughly chronologically, there is overlap in the time periods covered between the chapters. This dissertation is based on archival research in the papers of scientists at land-grant universities, especially the papers of Myer Jaffa, Edwin Ladd, and Harry Steenbock (housed at the University of California, Berkeley, North Dakota State University (in Fargo, North Dakota), and the University of Wisconsin, Madison, respectively), though it draws on the archived papers of other scientists in the Midwest and Northeast, as noted in the bibliography. It also uses the published bulletins and articles of agricultural scientists, as well as digitized newspapers reporting on their studies and lectures. In addition, Chapter 2 examines congressional documents to understand the place of science in debates over the movement for a pure food law, and Chapter 4 is largely based on archival research in the papers of the U.S. Food Administration at the Hoover Institution Archives at Stanford University. Throughout the dissertation, I also build on the secondary literature noted above as well as scholarship on the individual topics of each chapter. One of the goals of this dissertation is to bring scholarship on each of these five significant events into an overarching narrative, as I trace the agricultural tradition of nutrition science across these events.

Chapter 1 looks at the USDA dietary surveys that took place between 1894 and 1904. While scholars have focused on the rise of the nutrition laboratory during this period, I argue that these surveys represented a holistic, field-centered approach to studying nutrition, which was just as valuable as the laboratory studies. In the surveys, chemists visited the homes of their research subjects and not only analyzed the foods they ate and observed their health, but made general observations on the climate, environment, circumstances, and living conditions. I also examine the way that these surveys were conducted in the context of broader debates over citizenship, statehood, and race. These surveys show how institutional and regional context significantly shaped individual surveys, including the framing and conclusions of agricultural scientists.

The second chapter examines the scientific debates over "artificial foods" (or new industrially processed foods) in the Pure Food Movement, which resulted in the passage of the Pure Food and Drug Act in 1906. I argue that there was a divide between pure and manufacturing chemists and agricultural chemists over how to assess the health value of a food. While pure chemists argued with certainty for the value of new processed foods like oleomargarine, agricultural chemists expressed skepticism about the state of scientific knowledge. Moreover, chemists at many agricultural experiment stations, especially in the mid and far West, expressed caution about the impact of these manufactured foods on the food system more broadly. Rather than solely a technocratic movement among scientists, the debates demonstrate how, for agricultural chemists in the mid- to far- West, the Pure Food Movement was agrarian and populist.

The third chapter centers on the identification and isolation of vitamins around 1912. My argument has three parts: First, I argue that in the United States, the isolation of vitamins arose from the skepticism of agricultural scientists (especially in the mid- to far- West) in the current nutritional paradigm. These chemists explicitly challenged the ability of chemical methods to measure the healthfulness of fruits and vegetables in the period before vitamins, and one chemist, Stephen Babcock, consciously designed an experiment with the purpose of challenging the paradigm. Second, I argue that vitamins were discovered at this moment because they were being removed from diets on a large scale with industrialized processing (like polished rice) and the rise of monocultures, as well as from the diets of experimental animals. Scholars often examine the discovery of vitamins by asking "Why were vitamins discovered so late?" and outlining the barriers to their discovery (such as increased interest in germ theory). I instead ask, "Why vitamins now?" Last, I examine the way that the competition for priority claims and the Nobel Prize distorted the historical narrative, as scientists vying for priority often downplayed any precursors to the discovery of vitamins.

Chapter 4 examines the role of nutrition scientists in Hoover's US Food Administration during World War I. While I had expected war to be the place where the reductionist approach to nutrition among scientists began to be dominant, I was surprised to find that scientists were focused on food psychology as much as, if not more than, physiology or chemistry during this era. Scientists consistently wrote about needing rations to fulfill "psychological requirements" alongside writing about physiological requirements, and perhaps for this reason, popularized the science. But food psychology was also something that could be manipulated, and my chapter ends by suggesting that the wartime popularization of the science would also demonstrate the usefulness of the science in advertising campaigns for large food manufacturers.

The last chapter examines a shift that took place in university-industry partnerships in the field of nutrition science in the 1920s, using the University of Wisconsin as a significant case study. At the University of Wisconsin, Harry Steenbock developed a way to fortify foods with vitamin D through irradiation, and patented this process and sold the rights to Quaker Oats. This attracted the attention of many food corporations, who began funding "industrial fellowships" in the agricultural chemistry department at the University of Wisconsin. This was a part of a broader trend in university-industry partnerships across fields and across the United States, and food processors played a prominent role in funding research fellowships. During this decade, many food corporations also began hiring nutrition scientists (agricultural chemists as well as domestic scientists) to create products and conduct studies for marketing. The chapter traces the shift from nutrition scientists at Wisconsin positioning themselves as watchdogs of processed food corporations to partners of those food corporations. I argue that, paradoxically, some of the core elements of the alternative, agricultural tradition of nutrition science led to its decline.

In the conclusion, I turn to the topic of early histories of nutrition science as the discipline began to form in the 1920s. I examine why the agricultural tradition of nutrition research has played a small role in the historiography, and highlight why it should have a more prominent place.

Chapter 1: Sharing Meals for Science
U.S.D.A. Dietary Investigations from 1894-1904

In 1904, Charles Langworthy, "expert on foods and animal production" for the USDA Office of Experiment Stations, and Robert Milner, editorial assistant, wrote a bulletin that summarized the first decade of USDA research in human nutrition.[74] In the bulletin, they included two photographs of research spaces. One photo was of Wilbur Atwater's respiration calorimeter, a research space housed at the Storrs Agricultural Experiment Station in Connecticut and familiar to scholars of the history of nutrition science (Figure 3). Wilbur Atwater—known as the father of nutrition science in the United States, who organized and led the USDA's first human nutrition studies—used this airtight, ventilated device to precisely measure the output of heat, water vapor, carbon dioxide, and excreta of a human subject, who would live in the "copper box" throughout the experiment.[75] At the same time, Atwater could measure the nutrient intake through chemical analysis of the foods the subject consumed. Through this careful measurement of energy intake and output, Atwater studied the law of conservation of energy in relation to food and physiology. In the respiration calorimeter, the body was a machine, and food was its fuel.

The second photograph of a research space included in the bulletin is less familiar: The photograph depicts a group of Chinese truck farmers in Berkeley, California, gathering around a table to share a meal (Figure 4).[76] The meal was a part of a dietary study by a University of California chemist named Myer Jaffa. Jaffa's study examined the diets of Chinese Americans at various levels of society, including a dentist's family, a group of laundrymen, and, of course, the truck farmers in the photo. At a time of strong anti-Chinese sentiment in California, culminating in the renewal of the Chinese Exclusion Act in 1902, Jaffa shocked newspaper reporters by sitting down and sharing meals with this group of farmers (Figure 5).[77] Seated at the table of his research subjects, Jaffa studied nutrition in its cultural, environmental, and sociological context.

In their bulletin, Langworthy and Milner explained that there were two branches of nutrition investigation: one branch used the laboratory to break down the chemical components of food, while the other used observations of human diets to understand the laws of nutrition. "The former is concerned simply with the chemistry of food," Langworthy and Milner wrote, "while the

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[74] This chapter focuses on the studies conducted in the first decade of research, before Wilbur Atwater suffered from a debilitating stroke in 1904. It is worth noting that the studies continued until 1911, and then picked up again in 1926. In 1926, the studies shifted from being conducted by agricultural chemists and domestic scientists to purely conducted by home economists and rural sociologists. Robert Dirks and Nancy Duran, "Experiment Station Dietary Studies Prior to World War II: A Bibliography for the Study of Changing American Food Habits and Diet over Time," *The Journal of Nutrition* 128, no. 8 (1998): 1253–56.

[75] This is a reference to an 1897 article on Atwater's use of the calorimeter to understand the "healthful and economic feeding of humanity," and more importantly, the application of the laws of conservation of energy to the human body. "The Man in the Copper Box," *Century Illustrated Monthly Magazine,* volume 54, New York, June, 1897.

[76] A truck farm is a small-scale farm that grows fruits and vegetables for sale locally. Myer Jaffa wrote that this truck farm was locally called a "vegetable garden," but that it was "similar to hundreds of others in the State conducted entirely by the Chinese. In some cases only one crop is grown, but generally all kinds of vegetables are raised, and sometimes small fruits in addition. The size of these farms, which are usually leased, varies from a small patch to hundreds of acres, and the fields, almost without exception, are maintained at a very high state of cultivation" (35). Myer E. Jaffa, *Nutrition Investigations among Fruitarians and Chinese at the California Agricultural Experiment Station, 1899-1901* (Washington DC: Government Printing Office, 1901).

[77] "California College Professor Tries the Diet of John Chinaman", *The Sunday Call Magazine*, April 29, 1900, Myer Edward Jaffa Papers, BANC MSS C-B 1013, The Bancroft Library, University of California, Berkeley. (Hereafter, Jaffa Papers, Bancroft Library.)

latter has to do with the physiology, the physics and chemistry, of the nutrition of man, together with the economic and sociological application of the fundamental principles of nutrition to the diet of persons in different localities and under different conditions of life."[78] This holistic definition of the study of nutrition not only included the examination of human physiology and the chemistry of food, but also incorporated the study of economic, sociological, and environmental factors in diet. The photographs represent two approaches to studying human nutrition – one in the laboratory, and one in the field.

[78] Langworthy and Milner, *Investigations on the Nutrition of Man in the United States*, 8.

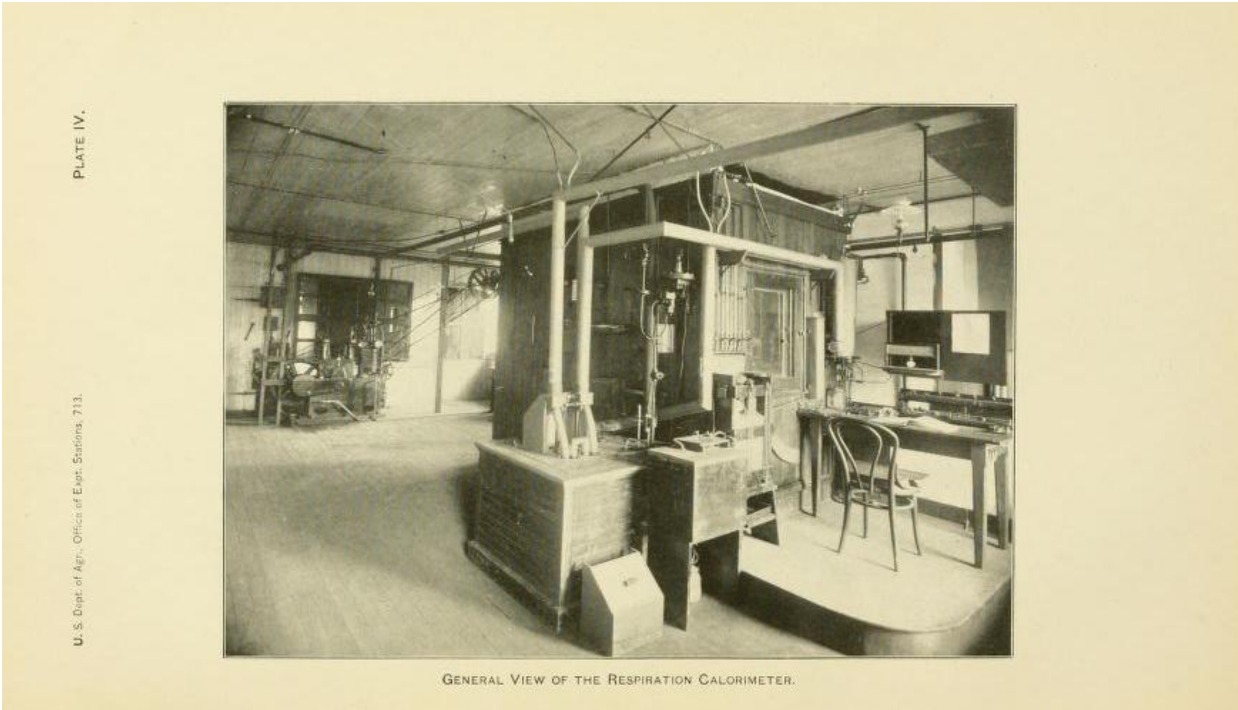

Figure 3: "General View of the Respiration Calorimeter," Charles F. Langworthy and Robert D. Milner, *Investigations on the Nutrition of Man in the United States* (Washington DC: Government Printing Office, 1904): Plate IV.

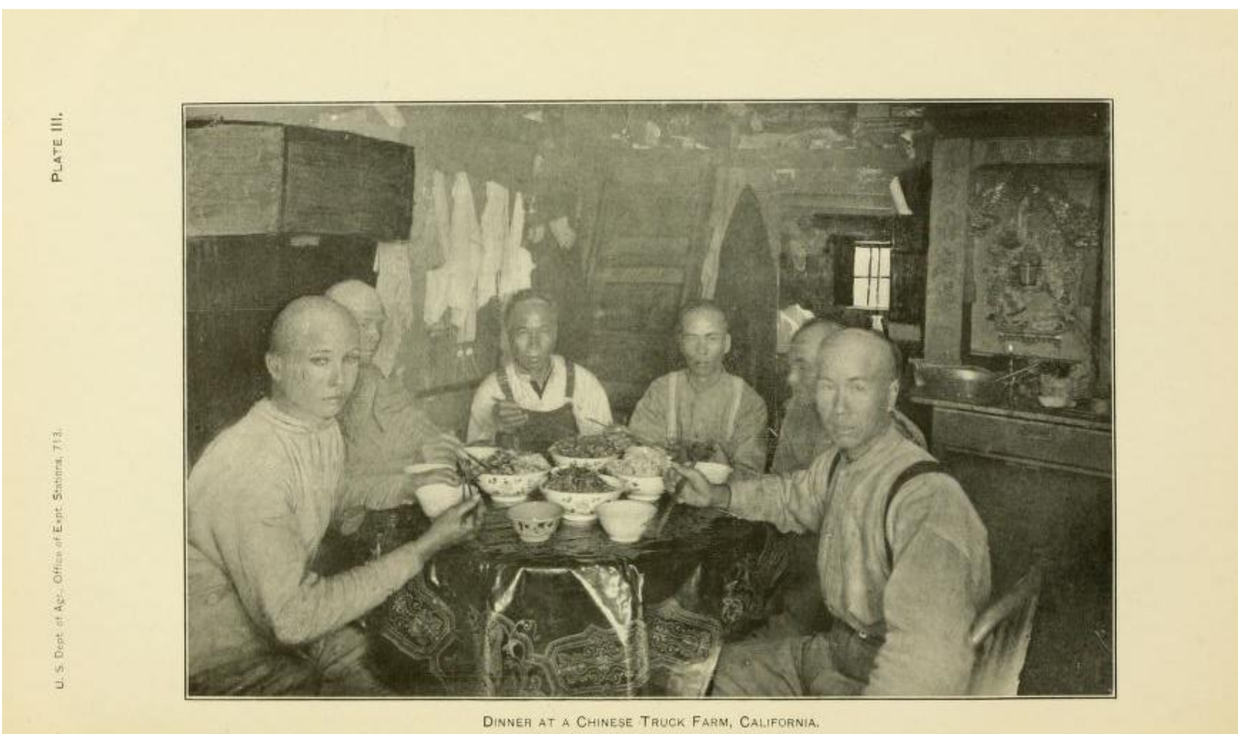

Figure 4: "Dinner at a Chinese Truck Farm," Charles F. Langworthy and Robert D. Milner, *Investigations on the Nutrition of Man in the United States* (Washington DC: Government Printing Office, 1904): Plate III.

Figure 5: "Professor M.E. Jaffa and Mr. T.J. Snow Dining with Gardener Charley Hop," in "California College Professor Tries the Diet of John Chinaman", *The Sunday Call Magazine*, April 29, 1900, California Digital Newspaper Collection.

Recent scholarship on nutrition science during this period has most often focused on Atwater and his calorimeter, generally tracing the history of nutrition science as the history of the rise of quantification and what food studies scholar Gyorgy Scrinis has called "nutritionism" – the view of food as chemical components with disregard for culture, taste, and social factors.[79] However, Myer Jaffa's study of the Chinese truck farmers is more representative of the approach to studying human nutrition in the United States during this period. In 1894, Congress approved funding for the USDA to coordinate studies in human nutrition at agricultural experiment stations throughout the United States. Atwater used this funding to build his calorimeter, while organizing other chemists at agricultural experiment stations and land-grant colleges to conduct dietary surveys. As Atwater worked with his calorimeter, throughout the United States, chemists traveled to the homes of research subjects and recorded the subjects' food intake and their observations of economic, environmental, cultural, and sociological factors in diet. They used the laboratory to measure the fat, protein, and carbohydrate content of foods consumed, but they interpreted this laboratory research in the specific context they observed. The dietary surveys provided a significant field-research component of early nutrition science, one which counters the narrative of scientific reductionism in early American nutrition science.

While scholars writing about the history of reductionism in nutrition science have focused on Atwater's calorimeter experiments during this period, those scholars who have examined the

[79] Scrinis, *Nutritionism*; Mudry, *Measured Meals*; Nick Cullather, "The Foreign Policy of the Calorie," *The American Historical Review* 112, no. 2 (2007): 337–64. Scrinis's concept of nutritionism was popularized by Michael Pollan in *In Defense of Food: An Eater's Manifesto* (New York: Penguin Press, 2008).

dietary surveys mostly focus on the handful of surveys directed by Atwater himself. Building off of the work of Naomi Aronson and Harvey Levenstein in the 1980s, scholars have frequently argued that the surveys were a means of social control—that the surveys used quantification to reduce the bodies of working class people to machines in order to argue that workers were wasteful in their spending habits and should adopt a more efficient, scientific diet.[80] Indeed, the initial purpose of federal funding for the U.S.D.A. experiments was to "investigate and report on the nutritive value of various articles and commodities used for human food, with special suggestion of full, wholesome, and edible rations less wasteful and more economical than those in common use"—in other words, to investigate whether Americans—especially working-class Americans—could eat more economically and efficiently. The earliest dietary surveys by Atwater and another leading chemist in nutrition science, Ellen Richards of MIT, certainly support this narrative. Atwater, Richards, and their co-investigators variously called their urban working-class research subjects "careless," "shiftless," and "ignorant" and generally described them as wasteful in their spending on food.[81] Yet, a few factors make these oft-cited surveys distinct from other dietary studies taking place throughout the United States—perhaps most importantly, these early dietary surveys were conducted in partnership with charitable organizations, but the majority of the dietary surveys were conducted by chemists—both agricultural and domestic scientists—working through agricultural colleges and experiment stations. Chemists at agricultural colleges and experiment stations outside of the Northeast had a very different institutional, geographical, and political context than Atwater and Richards, yet few scholars have examined the surveys conducted by these other chemists.[82]

Those arguing that the surveys were a means of social control generally argue that they did not serve a scientific purpose—that they were mainly a way for Atwater to secure funding and for home economists to establish scientific authority.[83] There are a handful of scholars who have examined the way the USDA surveys contributed to the development of the science itself—including two significant recent works—though these scholars have all focused on Atwater.[84] In a 2017 book chapter, historian Elizabeth Neswald, who has written on the cultural history of thermodynamics and on metabolism research, argued that early nutrition science was interdisciplinary, and that dietary surveys conducted internationally provided a field-research approach that complemented laboratory research. Though she references the USDA dietary surveys, her chapter largely focuses on how physiologists and chemists like Carl von Voit,

[80] Aronson, "Nutrition as a Social Problem: A Case Study of Entrepreneurial Strategy in Science"; Laura Shapiro, *Perfection Salad: Women and Cooking at the Turn of the Century* (Berkeley: University of California Press, 1986), 163–68; Biltekoff, *Eating Right in America*, 21–22; Coveney, *Food, Morals, and Meaning*, 75–78; Levenstein, *Revolution at the Table*, 73–80.

[81] Atwater and Woods, *Dietary Studies in New York City in 1895 and 1896*; Ellen H. Richards and Amelia Shapleigh, *Dietary Studies in Philadelphia and Chicago, 1892-93* (Washington DC: Government Printing Office, 1903).

[82] A third body of scholarship uses the data from the surveys to understand what the working class ate during this period. Katherine Turner primarily uses the surveys in this way, though she too notes how the surveys by Atwater and Richards critiqued the working class. Katherine Leonard Turner, *How the Other Half Ate: A History of Working-Class Meals at the Turn of the Century*, vol. 48 (Berkeley: University of California Press, 2014); Robert Dirks, *Food in the Gilded Age: What Ordinary Americans Ate* (Lanham, MD: Rowman & Littlefield, 2016).

[83] Aronson, "Nutrition as a Social Problem: A Case Study of Entrepreneurial Strategy in Science," 481; Levenstein, *Revolution at the Table*, 73–76.

[84] In *Protein and Energy,* Kenneth Carpenter describes how Atwater used the results of the dietary studies to argue for a higher protein standard than the widely accepted Voit standard. Carpenter discusses how Russell Chittenden challenged this standard partially because it was based on observations of dietaries; Chittenden conducted his own experiments on subjects who were given a low-protein diet and argued for a lower protein standard. Carpenter, *Protein and Energy*, 103–7.

Atwater, Russell Chittenden, and Francis Gano Benedict used dietary surveys and laboratory research to create standards, and particularly to debate the protein standard.[85] In her 2017 dissertation on nutrition science as a social question in the nineteenth century, Molly Laas devotes her last chapter to this line of argument by examining the work of Wilbur Atwater to organize the surveys, and particularly the way that he valued them as an important sociological component of the science of nutrition.[86] Both of these studies demonstrate how the surveys served a specific scientific purpose for Atwater, and both challenge the "quantitative-reductionist" and "social-control" narratives of Atwater's work.[87] This chapter reflects and expands these considerations with a systematic historical argument by examining the surveys themselves, and particularly surveys at agricultural colleges and experiment stations outside of the Northeast.[88]

Operating outside of the sites where the history of nutrition science has most commonly focused its attention, the dietary studies examined in this chapter produced surprising findings. Chemists regularly demonstrated that they were learning from their observations of the dietary choices and health of their research subjects. Though they did compare the diets to standards and place a value on efficiency, they also recognized the ambiguity of the standards and the nascent state of the science. They made it clear that they were using their dietary studies to build the laws of nutrition and understand the social, cultural, environmental, and psychological components of the laws.[89] In the 1890s, the study of nutrition across the United States had a significant component that was very much socially embedded, as scientists studied food choices within specific social conditions, cultures, and environments. Scientific understandings of nutrition were not only produced in the laboratory, but also at the tables of research subjects of diverse places, backgrounds, and social standings. Scientists investigating nutrition thus worked in diverse contexts – not solely in the context of New England reform movements. The specific institutional, geographical, and political context of the agricultural colleges and experiment stations shaped this field approach to nutrition science, and would give rise to a different tradition of nutrition science that would contend with the tradition at the "pure" research laboratories of the Northeast.

Current scholarship on early nutrition science has examined the cultural biases and racism of the science, and particularly the way that reformers pushed for a typical Anglo-American New England fare; but a number of dietary surveys—particularly surveys of the rural poor outside of

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85 Neswald, "Nutritional Knowledge between the Lab and the Field."

86 Laas, "Nutrition as a Social Question," 177–210.

87 Laas and Neswald both discuss the historiographic trends that I outline above. Laas, 139–41; Neswald, Smith, and Thoms, *Setting Nutritional Standards*, 1–5, 29–30.

88 I have argued for some time that the dietary surveys represented a field component of research, starting with a presentation on Myer Jaffa at the annual meeting of the History of Science Society in 2014. I argued that while early nutrition science has been characterized by quantitative reductionism, "Myer Jaffa does not fit these characterizations of early nutrition science largely due to his movements between the laboratory and the fields, and particularly due to his basis in the California agriculture. Nutrition science is situated in multiple landscapes, not only the laboratory, but also foodways and farmscapes, as well as kitchens and tables. In working directly with farmers and consumers, and using the laboratory as a mediator in a time when the food industry was undergoing vast transformations, Jaffa sought to bridge a connection between the California farmscape and the table in a holistic vision of nutrition science." Kimberly Killion, "Bringing California to the Table: Myer E. Jaffa and the Pure Food Movement," History of Science Society Annual Meeting, Chicago, November 2014. Neswald's chapter provides an international context for this work, by looking at how major scientists internationally and in the Northeast used dietary surveys to create standards, and thus broadens my claim about the dietary survey as a field research approach to the full discipline.

89 This argument directly counters a common portrayal of these surveys as invested in imposing a reductionist view on the research subjects. For example, Laura Shapiro has written that the method of the dietary surveys "led investigators to ignore anything that could not be tabulated." Shapiro, *Perfection Salad*, 166. See also: Mudry, *Measured Meals*, 42.

the Northeast—in fact argued for the *value* of immigrant or non-white cuisines.[90] These surveys were conducted during a period when there were national debates over the role of race in immigration, statehood, and citizenship, and food played a surprising role in the debates. The new understanding of food as chemical components of protein, fats, carbohydrates, and minerals certainly contributed to a dis-embedding of food from its social, cultural, and environmental contexts, as scholars tracing a narrative of reductionism have argued; but it also presented a new understanding of the place of food in racial, national, and class identity. When chemists demonstrated that the chemical components of tortillas, rice, corn meal and wheat bread were near identical in the contemporary scientific terms (or that some foods popularly viewed as inferior in fact had greater nutritional value), they made it difficult to argue that a group was inferior because of the food they ate.[91] This, of course, could be taken as a critique of the white working class, for not eating what the scientists claimed to be more economical fare that immigrant or non-white workers were consuming (and it was taken as such by white labor organizers at the time). The chemists commented on and observed the "Americanization" of certain groups, but they did not always place a greater value on established Anglo-American food preferences. Using chemistry, the scientists presented a new understanding of American foodways and identity.[92]

The first part of this chapter discusses the organization and scope of the USDA dietary surveys. In the second part, I closely examine three surveys that challenge the current scholarship on the dietary studies. These surveys show how the institutional and local political context influenced individual surveys, how chemists used observations to challenge chemically reductionist understandings of diet, and how some chemists also used chemistry to, at times, reach surprisingly multiculturalist conclusions. The chapter concludes with a discussion of physiological chemist Russell Chittenden's criticism of the dietary surveys. This criticism points to how, by 1904, the divide between the pure and applied branch of human nutrition science had become contentious – and, as we will see in the next chapter, would shape the debate over new, federal regulations of food production.

I. The Organization and Scope of the USDA Dietary Surveys, 1894-1904

In 1894, the US Congress approved the appropriation of ten thousand dollars for the Department of Agriculture to conduct studies in human nutrition in coordination with agricultural experiment stations throughout the United States. As scholars have noted, Wilbur Atwater was

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[90] For scholarship on the bias of scientists towards white, New England fare before WWI, see for example: Veit, *Modern Food, Moral Food*, 123–56; DuPuis, *Dangerous Digestion*, 54–74; Biltekoff, *Eating Right in America*, 25; Cravens, "The German-American Science of Racial Nutrition, 1870-1920."

[91] In the opening paragraph of her book, Helen Zoe Veit describes how, in the 1890s, a meal of a sharecropper and a meal served at a high-end restaurant would seem completely different, but by the 1910s, nutrition science would demonstrate that these meals could be nutritionally equivalent. This chapter demonstrates that this idea of nutritional equivalency has earlier roots in the science, dating back to the 1890s. Veit, *Modern Food, Moral Food*, 1.

[92] Jeffrey Pilcher's recent historiographical review on food history summarizes the recent trends in the scholarship which I have outlined in this introduction, which focus on quantification, social control, and racism. He writes: "In the late nineteenth century, Wilbur Atwater and Max Rubner developed the calorimeter as a way to measure the energy within food, which allowed the calculation of 'rational diets' as a scientific replacement for traditional cuisines […] Nutritionists insisted on the objectivity of their work, but as science studies scholars have shown, their recommendations advanced ideological agendas. One such goal of scientists and reformers was to improve the working classes' industrial productivity and military preparedness. In the Americas, indigenous populations, descendants of slaves, and immigrants were viewed as particularly backward in the eating habits, and nutrition reform became an important component of national assimilation programs." Jeffrey M. Pilcher, "The Embodied Imagination in Recent Writings on Food History," *The American Historical Review* 121, no. 3 (2016): 883–84.

the leading scientist advocating for this funding, and would coordinate the experiments in human nutrition. Atwater, with his colleague Samuel Johnson, had organized the campaign to establish agricultural experiment stations with the passage of the Hatch Act in 1887, and Atwater had been the first director of the Office of Experiment Stations. Atwater was also the leading authority on nutrition science in the United States. He had conducted experiments on food values for the U.S. Commission of Fish and Fisheries in 1879 and on diets for the Massachusetts Bureau of Statistics of Labor in 1886, and had written a series of articles on human nutrition for *Century Magazine* from 1887 to 1888.[93] Atwater used the new federal funding to build his respiration calorimeter (described in the introduction), and to coordinate the newly established experiment stations in a dietary survey of the United States.

To win this federal funding, Atwater had partnered with a well-connected Bostonian entrepreneur and self-styled economist named Edward Atkinson. Atkinson was a proponent of free trade economic theories, and he believed that teaching the working class to cook and eat economically could ameliorate working conditions without other types of labor reform (like creating a minimum wage). He had designed and created a fuel-efficient slow cooker called the Aladdin Oven, which could turn cheap portions of meat into a healthful meal. Atkinson had also worked to fund the New England Kitchen, an experimental kitchen run by Massachusetts Institute of Technology chemist Ellen Richards. He was a savvy networker, with connections to both politicians and philanthropists, and he had a personal connection to the new Secretary of Agriculture, J. Sterling Morton, who was appointed in 1893.[94] That year, the USDA published a bulletin written by Atkinson that argued for the establishment of food laboratories for human nutrition at the agricultural experiment stations. He claimed that the people of the United States were "the most wasteful in the world" in their eating and cooking, and argued that the food laboratories be modelled on the New England Kitchen (which, he was sure to write, had ten Aladdin Ovens).[95] Though the nutrition investigations would not be modelled on the New England Kitchen, Atkinson's framing of the purpose of nutrition experiments as promoting more economical and less wasteful diets appealed to congressmen and shaped the purpose of the appropriation. The statute specified that money would be used to "investigate and report on the nutritive value of various articles and commodities used for human food, with special suggestion of full, wholesome, and edible rations less wasteful and more economical than those in common use."[96]

Atkinson was not a scientist, but his framing of nutrition science as a way to critique the food choices of the poor has shaped how historians have written about the dietary studies. The dietary studies by Atwater and Richards do support the idea that the studies were a means of social critique, as those studies argued that working class people were "careless" in their food spending and even "prejudice[d] against economizing."[97] Yet, while Atwater and Richards may have

[93] Carpenter, *Protein and Energy*, 100–104.

[94] Many scholars writing on nutrition during this era have discussed Atkinson's role in early nutrition funding, most often conflating Atkinson's view with Atwater's and Richards'. Levenstein, Shapiro, and Aronson wrote the foundational works on the relationship of these three figures. Levenstein, *Revolution at the Table*, 45–59. Shapiro, *Perfection Salad*, 149–68; Aronson, "Nutrition as a Social Problem: A Case Study of Entrepreneurial Strategy in Science."

[95] Edward Atkinson, *Suggestions for the Establishment of Food Laboratories in Connection with the Agricultural Experiment Stations of the United States* (Washington DC: Government Printing Office, 1893), 9.

[96] An Act Making Appropriations for the Department of Agriculture for the Fiscal Year Ending June Thirtieth, Eighteen Hundred and Ninety-five: Nutrition, 28 Stat. 264-274 (1894), 271.

[97] Atwater and Woods, *Dietary Studies in New York City in 1895 and 1896*, 65.

strategically framed their studies in this way to appease Atkinson—who was largely responsible for soliciting funding for their research—and the Secretary of Agriculture –as it justified the government funding—they were also pursuing their own scientific goals. In fact, Atwater and Atkinson disagreed about the purpose of nutrition research at the experiment stations. Atkinson wanted the USDA to devote funding to the practical application of nutrition research, and thus model the food laboratories on the New England Kitchen. He criticized Atwater for being too focused on "high science" and even asked the Secretary of Agriculture to find a different person to head the nutrition experiments. "[W]hile I would recommend Prof. Atwater […] as a suitable man for the finer and higher investigations," Atkinson wrote to Secretary Morton, "I should not put him in charge of the organization of Food Experiment Stations at various places. That object requires some one of more horse sense and less devotion to absolute science."[98] As Molly Laas has noted, Atwater was able to convince the Secretary of Agriculture to continue funding his nutrition research despite Atkinson's critique, and after he secured this funding, their relationship declined. Atwater wrote disparagingly of Atkinson in private communications and refused to allow the USDA to include Atkinson's Aladdin Oven in their bulletins.[99] Atwater was determined that the main purpose of the agricultural experiment stations would be basic research, not the social reform work that Atkinson envisioned.

While Atwater may have framed the surveys that he conducted as a means to teach the poor proper food economy, he envisioned the dietary surveys as fulfilling a specific scientific purpose. In arguing for the surveys, Atwater discussed the need to "obtain reliable data upon the food economy of people in different parts of the country and under different conditions of age, sex, health, occupation, and environment," partially to improve diets, but also because the science was in its infancy, and based in part on "arbitrary assumptions." He wrote:

> The most satisfactory standards for dietaries must be based upon the quantities of nutrients best suited to the actual bodily needs of a particular individual or class, but unfortunately experimental data are too incomplete for reliable estimates of such physiological demands. On this account the so-called dietary standards are for the most part based upon the observed facts of food consumption.[100]

Atwater introduced his New York dietary study by writing that the data "forms an indispensable part of the general data of an adequate and comprehensive science of nutrition, especially in establishing dietary standards."[101] In the 1890s, Atwater in fact used his observations from surveys to argue for a different dietary standard than his European counterparts, one with a larger energy and protein requirement. "These differences are partly the result of more recent research in the science of nutrition, but are due chiefly to the evidence obtained from the study of American

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[98] Edward Atkinson to J. Sterling Morton (Secretary of Agriculture), September 22, 1893, Edward Atkinson Papers, Massachusetts Historical Society.

[99] Laas, "Nutrition as a Social Question," 154–56. Laas largely uses Atwater's correspondence from the Atwater Papers at Cornell to support her observation about the disagreement between Atwater and Atkinson. She notes that Atwater was aware that Atkinson had suggested that Morton choose someone else to be in charge of the nutrition investigations.

[100] Atwater and Woods, *Dietary Studies in New York City in 1895 and 1896*, 6.

[101] Wilbur O. Atwater and Arthur P. Bryant, *Dietary Studies in New York City in 1896 and 1897* (Washington DC: Government Printing Office, 1902), 7.

dietaries," he explained in 1898.[102] During this period, dietary standards were being built from observations of real diets, both in the U.S. and internationally.[103] Atwater outlined the need for both sociological and laboratory research on diet, though his focus was on the laboratory component.[104] The director of the Office of Experiment Stations, Alfred C. True, directly told Atwater to focus on the laboratory in 1895, writing: "I don't think you can afford to put much energy into local affairs or spread out too much into general sociological work."[105] While Atwater focused on pure science research in the laboratory with his calorimeter, many American chemists set out to study the sociological side of the laws of nutrition in the field.[106]

The majority of the dietary studies were conducted by chemists working for agricultural experiment stations and land-grant colleges. The chemists at agricultural colleges and experiment stations had a different set of stakeholders than Atwater and Richards, as they were partially funded by their state's taxpayers and they were not intimately connected to the fight for federal funding or to Edward Atkinson.[107] In his 1904 bulletin, Langworthy listed over twenty states and territories where dietary surveys were conducted, most often through agricultural colleges and experiment

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[102] Atwater and Woods, *Dietary Studies in New York City in 1895 and 1896*, 5–6. Carpenter also discusses Atwater's use of dietary surveys to challenge standards: Carpenter, *Protein and Energy*, 105–7.

[103] Neswald, "Nutritional Knowledge between the Lab and the Field."

[104] For example, in a letter to R. Fulton Cutting of the Society for Improvement of the Poor on the funding of nutrition research, Atwater wrote that there were two parts to the inquiry: "one to be made in the household and the market, the other in the laboratory." Wilbur Atwater to R. Fulton Cutting, March 19, 1894, Wilbur Olin Atwater papers, #2223. Division of Rare and Manuscript Collections, Cornell University Library (Hereafter, Atwater Papers, Cornell). In making an argument for funding of laboratory research, Atwater also alluded to this divide. In his 1892 report for the Storrs Agricultural Experiment Station, Atwater stated of nutrition science: "The subject is new, and definite information is wanting. The great need is for abstract inquiry. The underlying problems are the conservation of matter and the conservation of energy in the living organism. We shall not be able to tell how to get the most nutriment for our money and how to fit our food to our actual needs until these problems are more nearly solved. It is the old story, so true and yet so hard to make people believe—that the knowledge which on the surface seems least practical, is really the most indispensable and the most useful. Part of the inquiry that is wanted can and doubtless will be carried on a public cost, but the kind which reveals the fundamental laws of biological chemistry requires the atmosphere and the appliances of the university, and can be accomplished only by the endowment of research." Wilbur O. Atwater, "The Economy of Food," in *Fifth Annual Report of the Storrs School Agricultural Experiment Station, Storrs, Conn. 1892* (Middleton, CN: Pelton & King, Printers and Bookbinders, 1893), 190.

[105] Alfred Charles True to Wilbur O. Atwater, January 16, 1895, Atwater Papers, Cornell.

[106] Harvey Levenstein also recognized that Atwater and True argued that there were two branches of the science: one that was "statistical and sociological" and should be taken up by the Department of Labor, and the other was "chemical and sociological." Levenstein argued that Atwater continued to frame his work as part of a sociological inquiry largely to retain congressional funding, as Congress would not fund "pure science" research ventures. Levenstein's discussion of the dietary surveys largely argues that it was a way for Atwater to maintain funding for his calorimeter experiment and a way for home economists to gain some scientific credibility. Levenstein, *Revolution at the Table*, 74.

[107] While Atkinson certainly held sway over Atwater and Richards early on, his correspondence with other chemists was infrequent. He corresponded briefly with Isabel Bevier, a chemist who established the household science department at the University of Illinois, Champaign-Urbana, but Bevier made it clear that he had little influence on her research when she wrote critically of his "Aladdin Oven" invention. Atkinson did not take this criticism well, and wrote angrily in response: "As you are rather impatient I advise you to invent something useful in the way of a cooking apparatus, spend a thousand dollars more or less in your experiments, then begin to make the apparatus under your own supervision and try to introduce it pro bono public, charging just enough profit to get back the money that you have expended in the course of a year or two." He ended his letter: "I urgently advise you to invent apparatus to meet these cases and then to spend fifteen or twenty years in the effort to give away your ideas and to do a little something to overcome ignorance, incapacity, inertia, vile habits, cooking stoves which the devil invented, and to put a hole in the bottom of the American frying-pan, and when you have succeeded please advise me how to do it." Edward Atkinson to Isabel Bevier, January 12, 1903, Edward Atkinson Papers, Massachusetts Historical Society.

stations.[108] These agricultural chemists had a different institutional, geographical, and, in some ways, political context than chemists like Atwater and Richards in the Northeast. Despite the large geographic scope of the surveys and the prominent place of the agricultural colleges and experiment stations in these early nutrition studies, few scholars have examined the surveys conducted through the land-grant colleges and experiment stations outside of the Northeast.

From Atwater's perspective, there were several advantages of tying the agricultural experiment stations into a national dietary study. For one, local laboratories could be used to analyze the nutritional values of food items produced in various regions, which was especially important during this period when food was increasingly mobile and tied into a national market. New processing techniques, new railroad networks and refrigerated railcars, and increased urbanization had created a national food system in the late nineteenth century. As increasing numbers of Americans on the East Coast were eating fresh fruit from California, butter from Wisconsin, or Texas-raised beef slaughtered in Chicago, food scientists sought to understand how local geography might alter the value of various foods.[109] Chemists did not assume that food grown or produced in one place would have the same chemical composition as the same food grown or produced in another place, that, for example, butter from Massachusetts would have the same chemical composition as butter from Wisconsin.[110] Chemists in the mid and far West thus set out to analyze the chemical values of foodstuffs in their regions. Winthrop Stone, a chemist at Purdue University in Lafayette, Indiana, explained the purpose of analyzing foods produced in the "Middle West" in his 1896 bulletin:

> Such analyses have therefore a particular interest as giving accurate information regarding the composition of the food products of a certain locality. They also furnish a means of comparison with similar food products in other localities or countries; and, finally, they contribute to the general fund of information being accumulated for the purpose of general study of American foodstuffs.[111]

In the early dietary studies, the laboratories at the agricultural colleges and experiment stations were intimately tied to the local landscape, as chemists brought locally produced foods directly into the laboratory to analyze the composition.

In the dietary studies, each agricultural college and experiment station specialized in the particular food that was characteristic of their state or territory. This again reflected the formation of a national food system, as different regions specialized in different food products for a national

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[108] Langworthy and Milner, *Investigations on the Nutrition of Man in the United States*, 10–12.
[109] William Cronon describes this process of creating a national food system centered in the railroad hub of Chicago, connected farmers and ranchers in the West to consumers in the East. Cronon, *Nature's Metropolis*.
[110] In a dietary investigation in 1891, Woods and Atwater wrote that American chemists could not simply rely on the chemical analyses of food from Europe, as they could not be certain that the composition would be the same in different localities. In that bulletin, they specified the exact origin of many food items, including cream cheese "made at factory No. 10, Sandusky, N.Y.," hen's eggs "laid by grain-fed Plymouth Rock hens," and a white bread from a Middletown bakery made from a combination of white-wheat flour from St. Louis and spring-wheat flour from Indianapolis. Wilbur O. Atwater and Charles D. Woods, "Food Investigations," in *Fourth Annual Report of the Storrs School Agricultural Experiment Station, Storrs, Conn. 1891.* (Middleton, CN: Pelton & King, Printers and Bookbinders, 1892), 55–58.
[111] Winthrop E Stone, *Dietary Studies at Purdue University, Lafayette, Ind., in 1895* (Washington DC: Government Printing Office, 1896), 20. This need to study foodstuffs in specific regions is also noted in Arthur Goss's study in New Mexico: Arthur Goss, *Dietary Studies in New Mexico in 1895* (Washington DC: Government Printing Office, 1897), 3–4.

market. In a letter in 1906 urging Congress to continue funding nutrition investigations, Isabel Bevier, a chemist and head of the domestic science department at the University of Illinois in Champaign-Urbana, highlighted that "the living habits of people have been studied from Maine to California, from the Lakes to the Gulf of Mexico." She went on to describe the regional specialization of this research:

> Because Chicago furnishes so large a part of the meat of the world the investigations in that subject have been located in this region and the University of Illinois has had the honor and the privilege of conducting these investigations. The great Northwest being the granary of the world, the University of Minnesota has been the center of the investigations in wheat, flour and bread. The fruit question has been studied in California.[112]

This specialization shaped a division of labor among the chemists involved in the study. University of California chemist Myer Jaffa, for example, wrote to Atwater that he would specialize in "California food and food materials" despite his interest in the food value of bread (as chemists in Minnesota were focusing on the study of bread).[113] The specialization of nutrition scientists in their regional products and cuisines ensured a diversity in nutrition data that the scientists needed to create dietary standards.

While the use of the agricultural experiment stations was advantageous in creating a division of labor in nutrition studies through regional specialization, which connected the chemists and their laboratories to their local agricultural landscape, they were also useful due to their connection to the local population. Atwater and Director A.C. True hoped that connecting the dietary surveys to the land-grant colleges and experiment stations would help them gain popular local support for the dietary surveys. Atwater and True discussed this when Winthrop Stone asked that his university be named in the title of his dietary survey bulletin. Stone "thought it might help our cause in Indiana," True wrote to Atwater. "I didn't remember whether he had decided to do this but this is a point worth considering for the different States in which we are working. We must try to secure local support and this may be a great way. Of course, this is what we are doing in Tennessee and Missouri."[114] Working with the agricultural colleges and experiment stations could help the dietary surveys win the support of local populations in each region.

The connection between colleges and experiment stations and their local population was also essential in establishing trust between the researchers and their research subjects. Rather than self-reporting data, Atwater instructed researchers to visit the homes of their research subjects to record their dietary intake and make observations about their general living conditions and health. Molly Laas has revealed how Atwater modelled the dietary surveys after other social surveys during this period, and Atwater believed the surveys needed to be conducted by investigators who had sympathy with the research subjects.[115] The researcher, Atwater wrote, should "make his studies from their point of view as one with them [the research subjects], if not one of them. His method must be scientific but his spirit sympathetic."[116] The agricultural colleges and experiment stations provided a network of researchers who lived in or near the communities they studied.

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[112] Isabel Bevier to Whom It May Concern, May 8, 1906, Isabel Bevier Papers, 1879-1942, 1945-1955; Record Series 8/11/20, Box 11, University of Illinois Archives. (Hereafter, Bevier Papers, [Box #], University of Illinois Archives).
[113] Myer Jaffa to Wilbur Atwater, November 7, 1896, Jaffa Papers, Bancroft Library.
[114] A.C. True to W.O. Atwater, April 24, 1896, Atwater Papers, Cornell.
[115] Laas, "Nutrition as a Social Question," 192–93.
[116] Quoted in Laas, 192.

While Atwater needed researchers who would be sympathetic to local conditions –to be "one with them, if not one of them" –the nature of the surveys also required a high level of trust between research subjects and investigators, as the studies asked subjects to open their homes to researchers and expose their personal food choices to examination.[117] Several bulletins mentioned the initial hesitation of subjects to participate in the studies, particularly in urban centers. "Among the very ignorant much suspicion was encountered," Atwater wrote in his 1895 and 1896 Chicago study. Several of the Chicago families withdrew from the experiment, because, according to Atwater, they "did not appreciate the motive" and were sensitive to discussing their income and expenditures.[118] In her study in Pittsburgh, Isabel Bevier also discussed how one research subject stopped participating because her "neighbors were convinced that it was a scheme to see how much it actually cost for a man to live, in order that his wages might be reduced."[119] To overcome these suspicions, the researchers needed to gain the trust of their subjects, and they often used their connection to a land-grant university to secure it. Nearly every dietary study identified a person—often who worked for the agricultural college—who played an essential role in winning the trust of the research subjects.[120] An instructor in the University of California's Oriental languages department—W.N. Fong—acted as a translator and accompanied Myer Jaffa as he studied the diets of Chinese immigrants. Jaffa also noted that the truck farmers in the study sold produce to the residents of Berkeley, and a photograph of a produce peddler carrying Jaffa's baby daughter Aileen in his basket suggests that Jaffa was one of those customers (Figure 6).[121] In a study at Tuskegee in Alabama, "Mr. Green, the farm manager of the Institute, was very helpful in inducing families to allow the investigations to be carried on in their cabins."[122] The researchers attributed the admiration of the local population for Tuskegee in their ability to carry out the studies. Similarly, when Isabel Bevier arrived to conduct a study near the Hampton Institute in Virginia, she wrote: "Because of their love for Doctor H.B. Frissell [then president of the Hampton Institute], the colored people were willing to admit me to their homes and to give me a free hand in making this study."[123]

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[117] Ibid.

[118] Wilbur O. Atwater et al., *Dietary Studies in Chicago in 1895 and 1896: Conducted with the Cooperation of Jane Addams and Caroline L. Hunt, of Hull House* (Washington DC: Government Printing Office, 1898), 14.

[119] Isabel Bevier, *Nutrition Investigations in Pittsburgh, Pa., 1894-1896* (Washington DC: Government Printing Office, 1898), 31.

[120] Atwater and Woods noted the importance of a sympathetic physician who acted as an intermediary in the study in New York. Atwater and Woods, *Dietary Studies in New York City in 1895 and 1896*, 2, 7.

[121] Jaffa, *Nutrition Investigations among Fruitarians and Chinese*, 3, 35.

[122] Wilbur O. Atwater and Charles D. Woods, *Dietary Studies with Reference to the Food of the Negro in Alabama in 1895 and 1896* (Washington DC: Government Printing Office, 1897), 22.

[123] "Report Prepared for the Land Grant College Pioneer Meeting for Sybil Smith, Office of Experiment Stations, USDA," October 27, 1937, Bevier Papers, Box 14, University of Illinois Archives.

Figure 6: "Aileen Jaffa in Berkeley with the vegetable man—'Sam'" (caption written on the back of the photograph). Photographer unknown, no date [likely circa 1900/1901 – Aileen was born in 1900.], Adele Solomons Jaffa and Myer E. Jaffa family papers, BANC MSS 2010/626, The Magnes Collection of Jewish Art and Life, The Bancroft Library, University of California, Berkeley.

While the surveys were tied into a national study coordinated by Atwater, each survey was thus closely tied to their local agricultural geography and their local population. Working with agricultural experiment stations was advantageous for Atwater because it allowed for a division of labor (in looking at agricultural products particular to each region) and connected the project to researchers who had the support of their local communities. Yet, the connection to local populations and local agricultural production was not just advantageous to Atwater, it was a part of the mission of agricultural colleges and experiment stations. These state-funded research universities and laboratories had the mission of serving their state's taxpayers, and particularly the farmers of their states. Regional specialization not only allowed the dietary studies to include a diverse array of foods and cuisines, but it also allowed scientists to directly serve their state's population. Indeed, the federal statute that appropriated the nutrition research funding recognized this purpose, stipulating that the agricultural experiment stations would conduct investigations "in such a manner and to such an extent as may be warranted by a due regard to the varying conditions and needs of the respective States or Territories."[124]

Before turning to the surveys, we should note that the dietary studies were not only geographically diverse; they also looked at diverse cuisines in the United States, including the diets of non-Anglo-American communities. In some ways, examining diverse cuisines supported the scientific goals of the study – the need to look at diverse foods and diets to understand nutritional standards. Both Atkinson and Atwater expressed a great amount of interest in different cuisines from abroad. In his USDA bulletin arguing for funding of nutrition research, Atkinson wrote that "Each race, each country, and almost each section of each country, through a process of natural selection, appears to have reached a unit of food, simple or compound, in which 'the nutrients,' so-called, are to be found in about the right proportion." Not only had nearly every group of mankind developed a diet that met their needs, but according to Atkinson, they created these diets "in such a manner as to assure the maximum nutrition at the least cost" (clearly supporting his idea that a primary goal of nutrition science was economic efficiency).[125] Atkinson advocated for more widespread use of foods such as lentils, soy beans, tofu, pulse, and miso that were used in cuisines abroad.[126] He regularly implored government officials to study foreign foods. In 1888, he wrote to the Commissioner of Agriculture N.J. Coleman: "I have always puzzled to understand how the so-called rice-fed nations should be so strong and so capable of doing good work, in view of the fact that our highly-polished and carefully hulled Carolina rice does not contain the protein nitrogen which is absolutely necessary to nutrition and especially necessary to muscular strength." He concluded the letter: "Great nations exist upon rice, pulse, beans, and bean-oil, about whose nutrition, cultivation, and methods of production we know little of nothing."[127] Atkinson was particularly interested in foods that could replace meat. He wrote to Atwater that they should study "people like the Italians and the South Germans and others where meat is very scarce and where the conditions of climate do not call for so much fuel value in the fats." In the letter, he claimed, "The Japanese and the Chinese appear to have found out the secret of beans: we have not."[128] In a letter to a man organizing a dinner party for vegetarians, Atkinson recommended several foreign dishes, including "Mexican frijoles," "Egyptian lentils," and "salad with Chinese peanut oil."[129]

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[124] An Act Making Appropriations for the Department of Agriculture for the Fiscal Year Ending June Thirtieth, Eighteen Hundred and Ninety-five: Nutrition., 53rd Congress, 28 Stat. 264-274 (1894), 271.

[125] Atkinson, *Suggestions for the Establishment of Food Laboratories in Connection with the Agricultural Experiment Stations of the United States*, 9.

[126] He was particularly interested in miso, and discussed the possibility of adding miso to soups in the United States in several letters in 1892 and 1894. He wrote in one letter, for example, "I have been much interested in the investigation of the popular food of various nations. It would appear that each race or nation has discovered for itself through a process of natural selection a kind or combination of food materials that yields the nitrogen, starch, and fat in about the right proportions. The common food of Japan, I am told, is a ferment of rice and beans or rice and barley, called miso, —very cheap, very nutritious, and quite appetizing to those who have become used to it." Atkinson to Reverend Theodore M. Macnair, April 16, 1894. See also: Atkinson to Commissioner of Agriculture, May 11, 1892; Atkinson to Ellen Richards, March 22, 1892, Edward Atkinson Papers, Massachusetts Historical Society.

[127] Edward Atkinson to N.J. Coleman, Commissioner of Agriculture, August 28, 1888, Edward Atkinson Papers, Massachusetts Historical Society.

[128] Edward Atkinson to Wilbur Atwater, May 19, 1896, Atwater Papers, Cornell.

[129] Atkinson to Charles F. Wingate, April 23, 1894, Edward Atkinson Papers, Massachusetts Historical Society. Atkinson's interest in foreign foods partially came from exposure to immigrant cuisines in the United States. In several letters, Atkinson described shopping at immigrant markets. "I have discovered peanut oil of a very fine quality on sale in our Chinese quarters, imported by Chinamen for the consumption of their countrymen," he wrote to Lord Playfair on February 6, 1894. On February 16, 1895, he wrote to Major C.A. Woodruff: "You can get German lentils at rather a high price, twelve cents a pound at Park and Tilford's, New York, by whom they are sold to caterers for soups of the swell order. Common lentils are sold here the German and Italian grocers at four or five cents a pound."

Atkinson's interest in the nutritional value of foreign and immigrant cuisines led to public disputes with labor organizers, as Atkinson thought that various American workers could learn from the food habits of immigrants and foreigners. Atkinson was not a friend of labor organizers, and his general argument for using nutrition science to eat more economically was met with disdain from working people.[130] In 1894, when Atkinson spoke at a meeting of workingmen in Boston on "how to save money in buying and cooking food," he was "sneered at as 'Shin-bone' Atkinson," one journalist reported. A labor leader at the meeting responded: "We don't want to know how to cook a shinbone so it will taste like a beefsteak; we want the beefsteak. We earn it, and we want it."[131] The foreign foods that Atkinson so admired were seen as equivalent to the "shin-bone" fare by vocal labor organizers. In April of 1892, labor organizer and later Socialist presidential candidate Eugene V. Debs published a scathing article on Atkinson in his magazine. The article argued that Atkinson believed workingmen were required "to try any method which science, so-called, may desire, to get them down to the eating level of scavenger Italians, Hungarians, Poles, and other riff-raff of Europe, who, after centuries of degradation, have learned to live like vagabond dogs."[132] In a subsequent article, he repeated this claim, though instead of "Italians, Hungarians, Poles," he wrote that Atkinson believed workingmen should adopt the diet of "Chinese, Huns, and Dagos," who had similarly "learned to live but one remove from scavenger dogs."[133] Atkinson's use of science to demonstrate the merits of foreign cuisines, according to Debs, was largely to suppress labor organizations and their fight for higher wages. Atkinson responded to this criticism by employing the authority of nutrition science, arguing that all of his proposed bills of fares were "scientifically computed," while Debs' article contained "no statement

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Atkinson's references to immigrant markets represent how these groceries had influence outside of their given immigrant community during this period. Edward Atkinson Papers, Massachusetts Historical Society.

[130] Atkinson spoke and wrote against labor unions, the eight-hour work day, and minimum wage. In a speech in 1887, he argued that workingmen who were called "scabs" by unions were really "Squires of Work" (as opposed to "Knights of Labor"), who did not let others dictate how, when, or where they should work (In this instance, Atkinson was speaking in opposition to a regulated eight-hour workday). He often said that he was not opposed to unions, but did not think every worker should be subjected to the rule of unions. In 1898, Atkinson participated in a public debate with Samuel Gompers, President of the American Federation of Labor (and one of the authors of *Meat v. Rice*) over the idea of a minimum wage, which Atkinson fiercely criticized. "Plain Truths for Labor." *New York Times,* May 02, 1887; "Living Wages for Labor." *New York Times*, March 11, 1898.

[131] "Mr. Atkinson's Fate," *Fort Worth Daily Gazette* (Fort Worth, TX), Vol. 18, No. 53, Ed. 1, January 15, 1894. University of North Texas Libraries, The Portal to Texas History, texashistory.unt.edu/ark:/67531/metapth90031/ Atkinson responded to his critics by writing, "I think intelligent workmen are capable of weighing the shin-bone of beef against the jaw bone of an ass." Atkinson to J.C. McCormick, April 13, 1894, Edward Atkinson Papers, Massachusetts Historical Society.

[132] The article continued: "He is an active flea in the hair of the corporation dog, ceaselessly at work to demonstrate how low wages can be reduced and still keep the protesting souls of working men in their famishing bodies. This fawning sycophant, this aristocratic bootlicker, is never so much in his element as when advising workingmen to submit to slavish conditions, and in pointing out the life-giving qualities of garbage, when submitted to scientific cooking, aided by his patent range, which, taking a shin bone of a steer, potato peelings, a little salt and water, constitutes the basis of a square meal, upon which a man and his family can, for a nickel, grow sleek and fat, and in a few years, at seventy-five cents a day, become a millionaire." The article claimed that these "victims of autocratic oppression" (immigrants) will do work for half the wages of American workingmen, and claimed that Atkinson's belief that these immigrants had the "right to free contract" based on their "personal liberties" made clear his intention to "suppress labor organizations." "Edward Atkinson," *Locomotive Firemen's Magazine* (Terre Haute, IN), April, 1892.

[133] "Edward Atkinson," *Locomotive Firemen's Magazine* (Terre Haute, IN), June, 1892.

of fact, no figures, no argument." Debs questioned the "so-called" science and wrote that "American workingmen are resolving not to be further degraded scientifically or otherwise."[134]

The debate between Atkinson and Debs certainly supports the idea of nutrition science as a means of social control, and has received much attention in scholarship on nutrition science during this era.[135] Yet the exact impact of immigrant and non-white diets on early American nutrition science remains ambiguous in the current scholarship. Focusing on "Yankee reformers" in the Northeast (particularly Atkinson, Atwater, and Richards), E. Melanie DuPuis has most recently argued that "New England reformers made the Yankee diet the ideal form of American eating" and that groups like "newly freed African Americans, who struggled for the right to land to achieve subsistence" and "foreigners like the Chinese, who ate less meat" were "excluded from the definition of ideal citizens and stigmatized as disorderly."[136] Though she notes that industrialists and reformers were interested in the Chinese diet because they saw Chinese workers as disciplined and economical, Dupuis ultimately claims that reformers, nutritionists, and workers alike stigmatized the Chinese diet and supported the "milk and meat" diet. She writes:

> Unfortunately, this American exceptionalism entailed a stigmatization of other diets, including ones that contained some very worthwhile elements: grains, vegetables, and, in particular, fiber. While nutritionists advised cheap cuts of meat, there was no questioning the basic components of the meal—meat, milk, and flour. Vegetables, particularly greens, as well as beans and rice, were dietary elements associated with stigmatized groups. Meat and potatoes became the paragon of the American exceptionalism ideal, a diet that workers deserved and defended.[137]

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[134] Ibid. It is worth noting that Wilbur Atwater somewhat agreed with Debs' statements about the inferiority of the diet of workers in Europe. Atwater argued for a higher protein standard than his European colleagues because he believed European workers were undernourished. He wrote that "the European standards are based upon the food consumption of people whose plane of living is low in comparison with that of the people of the United States[…]To make the most of the man, to bring him to live as a man ought to live, he must be better fed than by these standards." Quoted in Neswald, "Nutritional Knowledge between the Lab and the Field," 40.

[135] Dupuis, Aronson, and Levenstein all write on this debate. Levenstein emphasizes that the debate represents Atkinson's desire to "obviate wage raises," and more generally, that the interest of nutrition reformers in foreign foods ignored the psychological elements of food, "with the smug assurance that…'science' [was] on their side," which Debs recognized in refusing to eat "like Huns." Aronson writes that the debate illuminates how the nutrition studies were meant to cast moral judgement unevenly on the poor and seriously disadvantage workers. Dupuis's more recent examination of the debate takes a more nuanced approach, recognizing the diversity of the working class by writing that nutrition research created "racial gut wars," though she focuses on the role of Chinese immigrants in the debate without discussing the many other immigrant groups referenced. She writes that Atkinson, Atwater, and Richards supported the Chinese diet because they admired the perceived "self-denial and discipline" of the Chinese, but according to workers like Debs, "the Chinese lifestyle, but especially the diet, was considered unnatural, unmanly, and un-American." Like Levenstein and Aronson, Dupuis describes how meat-eating was seen as a "birthright" by American workers, and how nutrition professionals failed to recognize this when they encouraged them to eat less meat. Harvey Levenstein, "The New England Kitchen and the Origins of Modern American Eating Habits," *American Quarterly* 32, no. 4 (1980): 383; Aronson, "Nutrition as a Social Problem: A Case Study of Entrepreneurial Strategy in Science," 481–83; DuPuis, *Dangerous Digestion*, 71.

[136] DuPuis, *Dangerous Digestion*, 54.

[137] DuPuis, 72. This claim that Atkinson, Richards, and Atwater largely sought to improve and Americanize immigrant diets is made frequently in scholarship. For example, Alice Ross writes that Richards sought to improve the immigrant diet and "[her] colleague Edward Atkinson proclaimed such foreign foods un-American and unscientific." Alice Ross, "Health and Diet in 19th-Century America: A Food Historian's Point of View," *Historical Archaeology* 27, no. 2 (January 1, 1993): 47.

Dupuis concludes that "Nutrition advice therefore followed racial, ethnic, and sectional politics that sacralized the cream-based New England diet and treated other peoples' eating as degenerate and less civilized."[138] While this statement applies to some New England reformers, it does not apply to Atkinson, or to many of the chemists who conducted dietary surveys.[139] As Dupuis is largely interested in reform efforts and dietary advice, she does not examine the dietary surveys in her study.

The next section of this chapter closely examines three dietary surveys: New Mexico College of Agriculture and Mechanic Arts chemist Arthur Goss's study of Mexican American diets in Las Cruces, New Mexico; University of California chemist Myer Jaffa's study of the diet of Chinese immigrants in the San Francisco Bay Area; and soon-to-be University of Illinois chemist Isabel Bevier and president of the Hampton Normal and Agricultural Institute Hollis Frissell's study of African American diets in Virginia. I selected these three studies because they examine rural populations; they were conducted outside of the Northeast; and they are structured quite similarly—each dietary survey examined families of a specific race/ethnicity living in the same geographic area but of differing social statuses and income. Goss and Jaffa studied dietaries of communities local to their agricultural colleges; Bevier, who at the time was working in Ellen Richards's laboratory at the Massachusetts Institute of Technology, traveled to the Hampton Institute and worked with the president of the university to conduct the study. All three studies took place when the connections between race, Americanization, citizenship, and food were being debated. All three surveys examine non-Anglo-American diets, including two groups directly referenced as stigmatized by Dupuis—African Americans in the South and Chinese immigrants—yet the chemists came to dramatically different conclusions than Dupuis's Yankee reformers.

II. Race, Class, Americanization, and Food in Three Dietary Surveys

Arthur Goss's Study of Mexican Dietaries in New Mexico

One year after Atwater won funding for the USDA to study human nutrition, Arthur Goss set out to study the diets of Mexican families in the territory of New Mexico. Born and raised in Indiana, Goss had earned degrees in agricultural chemistry from Purdue University. In 1891, the recently established New Mexico College of Agriculture and Mechanic Arts (now New Mexico State University) hired Goss as an agricultural chemist.[140] The land-grant college was established

[138] Dupuis also points out how foreign, non-white cuisines were in fact quite nutritious. In some ways, her arguments sound similar to how Edward Atkinson used nutrition science to argue for the merits of foreign cuisine. DuPuis, *Dangerous Digestion*, 92.

[139] Atwater's dietary studies did notably criticize some immigrant cuisines. His bulletin on the diet of Italian immigrants in Chicago in 1895 and 1896 was particularly harsh. Quoting one of the researchers (presumably either H.M. Smith or a Hull House worker), the bulletin criticized the purchase of imported oil, wine, and cheese, and argued that stubbornness in diet had created a barrier to progress for these immigrants. Atwater et al., *Dietary Studies in Chicago in 1895 and 1896*, 15–16.

[140] In 1890, Goss worked with C.S. Plumb at the agricultural experiment station at Purdue University. By 1905, Arthur Goss was serving as director of that agricultural experiment station and as State Chemist of Indiana. He wrote a few bulletins on chemical fertilizers. New Mexico State University holds a small collection of photographs shot by Goss. The photographs in the bulletin may have been his own. Arthur Goss family photographs, New Mexico State University Library Archives and Special Collections. James Troop et al., *Purdue University. Agricultural Experiment Station, Bulletin No. 33, Vol II, October 1890* (Lafayette, Ind.: Purdue University Agricultural Experiment Station, 1890), //catalog.hathitrust.org/Record/100073721; Arthur Goss and W. J. Jones, *Commercial Fertilizers*, 44 p. (Lafayette, Ind.: Published by the author, 1904), //catalog.hathitrust.org/Record/102634586.

in 1888 in Las Cruces, a town in the Mesilla Valley of the Rio Grande that had developed around the recently built railroad depot. The land of New Mexico became a U.S. territory with the treaty of Guadalupe Hidalgo in 1848, but would not become a state until 1912. Goss began his study during a period when many New Mexican residents were arguing for statehood.

The debates over statehood reveal the image of New Mexicans held by Goss's national audience when he set out to conduct his dietary study. The public debate over statehood centered on whether the people of New Mexico were sufficiently American, or capable of being "Americanized." In *Debating American Identity,* Linda Noel writes that the debate over statehood was largely "one of whether or not people of Mexican descent could fit within the nation without harming national homogeneity and unity."[141] On one side of the debate stood the exclusionists, who argued against granting statehood to Southwest territories and campaigned for closed borders (which also included work for the Chinese Exclusion Act). Exclusionists argued that New Mexicans lacked the "biological capacity"—or racial makeup—to rise in class status to satisfactorily become Americans. In 1888, for example, the *Chicago Tribune* declared that the idea of statehood for New Mexico was "absurd" because no other part of the country was "so un-American and so little capable of operating a state government. Her people are composed largely of Aztec Indians and Spanish half-breeds, together with a few full-blooded Spaniards and the conglomerate known as 'Greasers.'"[142] In 1894, one year before Goss conducted his study, the *Tribune* wrote in response to the House passing a bill for statehood: "the House thus declared its willingness that the ignorant, superstitious, mongrel population of New Mexico, speaking a foreign language, ignorant of republican institutions, unfitted in every way for Statehood" would vote on an equal footing with other states in the U.S. Senate.[143] In the debate, exclusionists often compared New Mexicans to the Chinese, emphasizing race and language as the key obstacles to their ability to become American.

On the other side of the debate stood the assimilationists, reformers and educators who argued that New Mexicans were capable of becoming "American." In the same year they published an article condemning New Mexican statehood, the *Chicago Tribune* also published an article in support of American citizenship for New Mexicans:

> For they are native citizens, born on this soil, lovers of its plains and mountains, trained to look upon the United States as their paternal government, and to revere its laws. They spurn the distinction between themselves and Americans. Said one: 'We are more Americans than the Irish and Germans in your Eastern cities, who haven't been in the country six months.'

Yet the article also emphasized the Spanish heritage of New Mexicans, writing that they were of European descent.[144] Often assimilationists portrayed New Mexicans as a simple and ignorant group of people that needed to be educated to become American. A *New York Times* article argued that New Mexicans were not a lazy or thieving people, but hardworking and had a simpler lifestyle.

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141 Linda C. Noel, *Debating American Identity: Southwestern Statehood and Mexican Immigration* (Tucson: University of Arizona Press, 2014), 24.
142 "The Proposed New States," *Chicago Daily Tribune,* December 7, 1888.
143 "The Admission of New Mexico," *Chicago Daily Tribune,* June 29, 1894.
144 For example, the article wrote of one New Mexican, that though in lifestyle he may look like "an ordinary Mexican [...] look closer: the skin is lighter than that of the swarthy Mexican around the streets, his eyes are gray and keen, and his manner, though indolent, is imperious to his peons. He is a don of almost pure Spanish descent." "In Fair New Mexico," *Chicago Daily Tribune,* January 14, 1894.

Though they may be improvident, the article wrote, this is because "no one of the superior race has made an effort to induce them to be otherwise…[New Mexicans] have never been taught to look upon themselves as Americans. They are aliens and foreigners still in all their ideas." [145] The article argued that though New Mexicans may be simple, ignorant, and foreign, it was possible to Americanize them. Assimilationists argued that New Mexicans were white (emphasizing their Spanish heritage and separating them from "Aztec Indians") and that they were already assimilating "becoming literate, learning English, and rejecting traditional customs and lifestyles in favor of Anglo American ones."[146] White supremacy and racism were prevalent in both views: for exclusionists, race was a biological barrier to assimilation; for assimilationists, New Mexicans could learn from the so-called "superior race" and assimilate.

While race and language were at the center of assessing Americanization, food played a significant role in the debates. Journalists like Morris Watson claimed that "the 'common food' [New Mexicans] ate and their lack of silverware and practical furnishings" demonstrated that "'the spirit of progress do[es] not appeal to them.'"[147] In an 1886 *New York Times* article on the rugged, male culture of New Mexico, the author wrote:

> Philosophers say that climate and diet have a powerful effect on morals. If this be true, can you inform me how morals will develop […] where the steady diet of the average citizen is red pepper, onions, and blue beans? Without red pepper the greaser's life would be a burden to him. The pods he uses are long as your hand and hotter than a blast furnace, and one of them taken inwardly will smelt all the Christianity out of a white man in three minutes. The onions are large as a soup plate, and have the happy knack of giving their consumer a breath like a buzzard. Of the blue beans I will simply say nothing. Now, when a native hives away daily three large luxurious meals of these edibles, and never hears a sermon, I ask you fair-minded man if you can expect him to be sensitive on delicate questions of etiquette and propriety?[148]

While Watson argued that the food demonstrated the inferiority or laziness of New Mexicans, this journalist went further to perhaps jokingly imply that those foods in fact shaped their "uncivilized" and "immoral" qualities. Like Sylvester Graham and other dieticians of the nineteenth century, the *Times* author suggested that food altered a person's religious, moral, and intellectual character.

While those against statehood portrayed the foods themselves as un-American, and even a threat to American values, they also depicted New Mexican cooking as decidedly uncivilized, often associating it—at times in a positive light—with a rugged masculine culture in the territory. An 1890 *Los Angeles Times* article described phenomenon of "baching it," or "how the lone dweller in the wilds of New Mexico wrestles with his daily bread."[149] According to the article, the ability to cook for oneself defined the bachelor lifestyle, and the author comically detailed his masculine cooking endeavors and celebrated his independence from feminine domesticity. In the article, the author's marketing consisted of procuring "a sack of green coffee, a sack of flour, a sack of potatoes, a ham, sugar, maple syrup, salt, baking-powder, lard, apples, rice and 60 pounds

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[145] "The People of New Mexico: Their Modes of Life and Peculiar Traits," *New York Times,* June 20, 1880.
[146] Noel, *Debating American Identity*, 36.
[147] Quoted in: Noel, 30.
[148] "Glimpse of the Greaser," *New York Times,* January 29, 1886.
[149] Lum, "'Baching It.': An Insidious Southwestern Vice and Its Devotees. How the Lone Dweller in the Wilds of New Mexico Wrestles with his Daily Bread," *Los Angeles Times,* January 6, 1890.

of *frigoles* [*sic*]," which he packed into "two gunny sacks." After he set up his adobe kitchen, he became anxious and "felt as if I were about to be married or something dreadful." Yet, by the end of the article, after much practice, the author had learned how to cook various dishes, from chili con carne to frijoles, which he described as "the rich, voluptuous brunette bean of the Southwest—the belle of New Spain, as its inferior little white sister is the belle of Boston. In New Mexico particularly the bean is the cornerstone of our liberties." This praise of New Mexican foods was linked to the author's celebration of masculine independence, particularly from marriage and domesticity. In doing so, the author defined New Mexico as markedly unrefined, and asked "When such is the case, what wonder that New Mexico and Arizona can't get Statehood?"[150] Both New Mexican cooking—by single men in adobe kitchens—and food– from chilies to frijoles— were depicted as uncivilized.

Not only was the New Mexican diet portrayed as un-American, immoral, and uncivilized, but it was also seen as seriously lacking in nutrients and energy. This argument was even made in congressional debates over statehood. In second session of the 57th Congress in 1903, Senator John Kean "disparaged people of Mexican descent in both territories [Arizona and New Mexico] for their willingness to live 'as a Chinaman,' eating only 'a few mesquite beans and a little bacon fat' to sustain themselves."[151] No white American, the senator claimed, could live by such a low standard. In his letter of transmittal at the start of Goss's study, Alfred C. True, the director of Office of Experiment Stations, described this belief that Mexicans were able to survive on a scanty diet, writing: "The Mexican families of the poorer class live in a very primitive manner, and are usually gathered into small groups, who farm the adjacent land. The income outside of their small crops is very meager, consisting chiefly of what they receive for odd jobs of work. Casual observers of their habits are often puzzled to know what they live on."[152] These beliefs about the character of the food of New Mexicans – beliefs used to assess "Americanization" and determine statehood and citizenship—provided the broader context of understandings of the New Mexican diet when Goss set out to learn what exactly the people of New Mexico ate.

While the debates over statehood provide one context for understanding Goss's dietary study, this should not overshadow the larger purpose of the study. As a part of Atwater's national survey of working-class diets, Goss sought to observe and analyze how his research subjects made dietary choices in their given environments and economic circumstances, how these choices influenced their health, and what they might reveal about the principles of nutrition. Goss's 1895 study and 1898 follow-up study focused on Mexican, or Spanish-speaking, people in New Mexico, who made up the majority of the territory's population. Goss was accompanied by a graduate of the New Mexico College of Agriculture and Mechanic Arts—Mr. Fabian Garcia—who served as an interpreter.[153] Goss examined three families: two "very poor" families in rural areas and one "of moderate circumstances" living in Las Cruces.

Like many USDA bulletins, he began by discussing the agricultural landscape and the living conditions of his research subjects. Providing photographs in his subsequent bulletin (Figure 7), he wrote that well-to-do Mexicans live in similar circumstances as those in the East, but that poorer Mexicans "live in a very primitive manner."[154] Poorer New Mexican families lived in houses together, he explained, often occupying a single room with boarded windows, bare dirt

[150] Ibid.
[151] Noel, *Debating American Identity*, 30.
[152] Goss, *Dietary Studies in New Mexico in 1895*, 3.
[153] Ibid.
[154] Goss, *Dietary Studies in New Mexico in 1895*, 3.

floors, and roofs of brush. Yet Goss also explained that "rain seldom falls," and concluded his description of the adobe houses by arguing that though they may have a "very peculiar, box-like and unprepossessing appearance," the houses "are, however, about the most comfortable residences for this country, the thick walls serving to equalize the temperature."[155] Mexicans of all classes and many Americans, Goss emphasized, lived in adobe houses. This directly challenged the assessment of adobe buildings made by the congressional Committee on Territories, chaired by the Senator Albert J. Beveridge, an exclusionist who argued against statehood for New Mexico. Historian Linda Noel writes that the committee "condemned the adobe buildings in which many people of Mexican descent resided and compared them with the 'common and usual homes of the Chinese people,' by which they meant that they were primitive and un-American."[156] Goss defended the use of adobe homes as well adapted to the unique New Mexico climate, before turning to the diet of his research subjects.

Rather than disparaging the dietaries of research subjects as wasteful, or stigmatizing foods that were outside of Anglo-American fare, Goss appeared to be learning from his observations and used nutritional science to understand the dietary choices. He explained that poor New Mexicans rented land and paid rent in grain, using the only arable land along the river. They raised most of their food, including beans, peas, lentils, and chilies. The first three were "used to supply the protein necessary in the absence of meats and other nitrogenous foods of animal origin." Of chili, he wrote, it "is probably used more for its stimulating effect on the digestive organs than for the actual amount of nutrients which is furnishes. It or some similar substance is said to be almost essential in the diet of people living in warm countries, who depend almost entirely upon vegetable matter for their food." Though chemical analysis at this time revealed few nutrients in chilies, Goss argued that it served a useful purpose in their diet. Budget dictated whether the subjects purchased corn or flour. "If it is necessary to reduce the cost of living to the minimum, as is often the case," Goss explained, "more corn and less flour are used." The poor families in New Mexico also purchased coffee (used "universally and in large quantities") and lard. "As the vegetable foods usually contain very little fat, it is necessary to increase the amount of this substance by addition of outside sources, usually either lard compound or beef tallow, which are the cheapest forms of fat in this region," Goss wrote to explain the purchase of lard.[157] Throughout the bulletin, Goss used his authority to scientifically justify the subjects' dietary choices.

[155] Goss, 5.
[156] Noel, *Debating American Identity*, 30.
[157] Goss, *Dietary Studies in New Mexico in 1895*, 6.

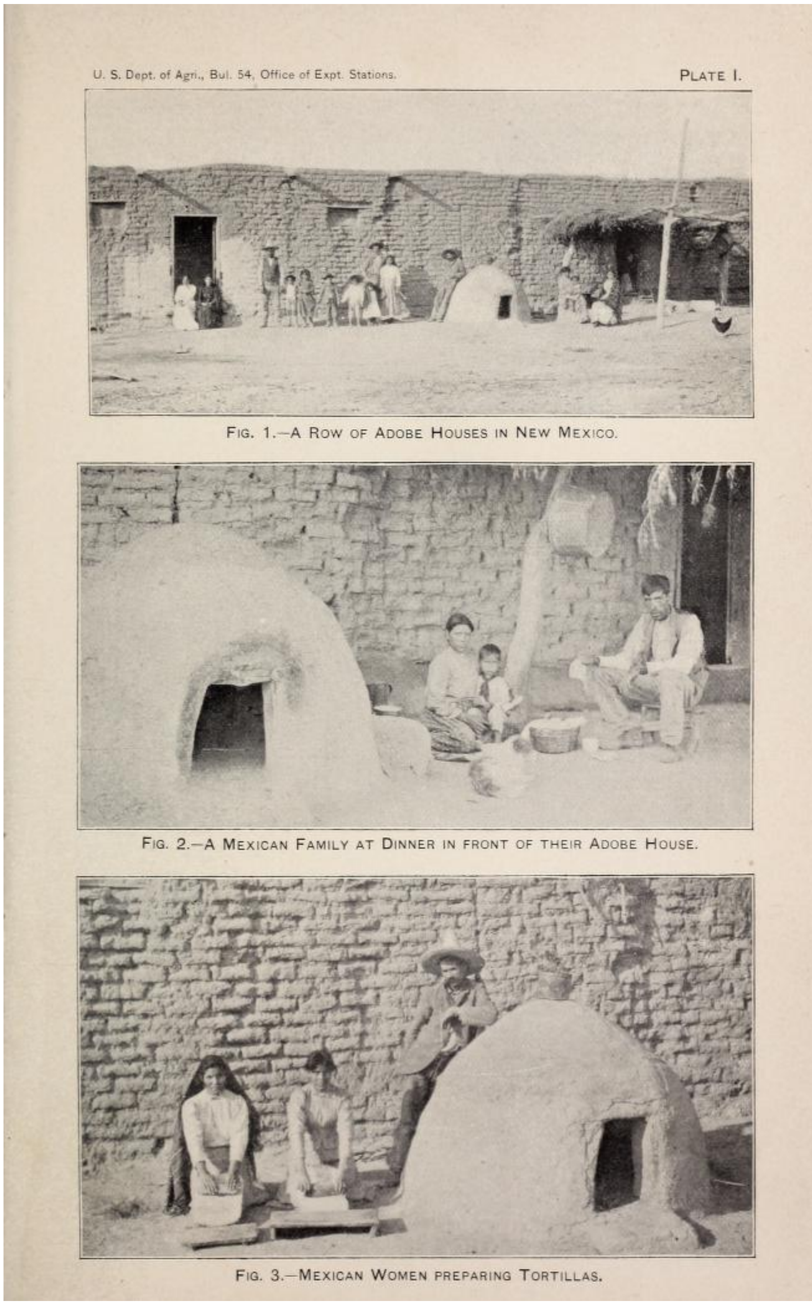

Figure 7: Goss was a photographer, and may have taken and staged these photographs himself. Though eating and preparing food outdoors and on the ground may have seemed foreign and unrefined to East Coast readers, one might note the way that the photos' depiction of food preparation and family mirrored more widespread traditional domestic ideals. Goss, Arthur. *Nutrition Investigations in New Mexico in 1897*. Washington DC: Government Printing Office, 1898. Plate I.

As Goss moved from the rural families to the improved circumstances in Las Cruces, he emphasized that the diet became more similar to American diets in the East. Rather than cooking over an open fire, sitting on animal skins on the floor, and eating without knives, forks, or plates, the family in Las Cruces had homes where "the stove and table make their appearance, and the meals are cooked and served more nearly in the American manner." Goss wrote: "In passing from the poor to the well-to-do classes, and from the country to the towns, the manners and customs become more and more Americanized, until finally there is little difference in respects between Americans and Mexicans." Like the assimilationist arguments being made about New Mexico in the statehood debates, Goss's bulletin made the argument that people of Mexican heritage could be "Americanized." Yet when it came to food, his view of Americanization was not straightforward. The family in Las Cruces used "a greater variety of food…including some meats and other animal foods," but they still ate traditional Mexican foods: "The frijoles and chili, however, are never discarded from the Mexican diet, no matter how high the station in life."[158]

Goss's bulletin did present some criticisms of the diets, but overall, his study pointed to the merits of traditional Mexican foods.[159] With one of the poorer families, he noted that the adults "had an anaemic appearance and seemed to be poorly nourished" which was "as usual with Mexicans of the poorer class,"[160] and in his final analysis, he showed that the protein-carbohydrate ratio of the rural families was slightly lower than other American dietaries (though he wrote that the ratio was higher than that in a dietary study of Black families in Alabama.)[161] Yet he did not recommend they adopt a different cuisine - he recommended that the families "eat more frijoles and lard and less flour and other carbohydrate food."[162] He recognized the limits of circumstances with the rural families, and wrote that "very little food was wasted" and that "many of our American families could study this point to advantage." According to his analysis, people in New Mexico were able to live on seven cents per day even with expensive provisions such as coffee. The poorest people were able to live on even less by substituting corn for flour, Goss wrote, praising the use of a food more associated with traditional Mexican foods (corn) over its Anglo alternate (flour). "No one need starve in this country," Goss concluded.[163] This clearly echoes the arguments of Atkinson, as it implied that working people should adopt the New Mexican diet to save money—even when Goss had noted that the family had anemic appearance. Goss noted that the family with greater means also looked better nourished than the rural families, which he attributed to their greater variety of food (and particularly access to meat).[164]

Goss's study does not neatly fit into the current explanation of Atwater's national study of the working class, as it neither criticized the spending of the rural families nor argued for the supremacy of New England cuisine. Americanization and cost were certainly themes in Goss's study, and he did describe Mexicans of the higher circumstances as "Americanized" and identify so-called inefficiencies in the protein-carbohydrate ratio of the diet, but he did not argue that the New Mexican diet and foods were lesser. He used chemistry to explain the values of frijoles, lard, and corn; and when chemistry failed to support the use of chili, he justified its use by pointing to tradition. Goss placed value on variety that the higher-class Mexicans were able to access, but did not disparage their use of chilies and frijoles, which he closely associated with their New Mexican environment. Situating this study in the debates over statehood taking place at the time, Goss

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[158] Goss, 7.

[159] He wrote that with all three families "the amount of protein per man per day is rather less than the average of other American dietaries except in the case of the negroes." Note that here, he seemed to be saying that all of these dietaries are "American." He wrote that the "rations are not well balanced, the nutritive ratio being rather wide" because they ate more carbohydrates and less protein and fat than other American diets. Goss, 22–23.

[160] Goss, 14.

[161] In his second report, which is just one dietary study, he emphasized this point, writing that "In both the negro and Mexican families the dietaries are deficient in protein and fuel ingredients." Arthur Goss, *Nutrition Investigations in New Mexico in 1897* (Washington DC: Government Printing Office, 1898), 20.

[162] Goss, *Dietary Studies in New Mexico in 1895*, 22.

[163] Goss, 23.

[164] Goss, 16, 23.

appears to be neither an exclusionist nor quite an assimilationist. From the point of view of a chemist, the foods of New Mexico were not "uncivilized"—they were the potential components of a nutritious diet.

Isabel Bevier and Hollis Frissell's Study of African American Dietaries in Virginia

In 1898, Atwater wrote to Isabel Bevier asking her to conduct a dietary study of African Americans in Virginia. Born in Plymouth, Ohio in 1860, Bevier began teaching at the Pennsylvania College of Women in 1888. Bevier met Ellen Richards at the Columbian Exposition in 1893, and, soon after, was introduced to Atwater and Harvey Wiley (prominent in the next chapter) in Washington D.C. She began working in Atwater's laboratory in 1894 under the supervision of Charles Langworthy, and in 1897, she joined Ellen Richards at MIT. When Atwater asked her to conduct the Virginia study, she initially hesitated: "I replied that the making of dietary studies at any time was considerable of an undertaking, but I thought in the warm weather and among colored people, it would be a difficult task." Yet Ellen Richards insisted, "Why, of course you will go. You cannot afford professionally not to. Professor Atwater has asked you and it is a great chance." Bevier took up the investigation, which she later described as "a wonderful new chapter in my life."[165] Just two years after conducting this study, she was hired by the University of Illinois to establish their household science department.

Bevier conducted and published the Virginia dietary study with Dr. Hollis Burke Frissell, then president of the Hampton Institute, which was at the time an agricultural college devoted to the education of African Americans and Native Americans. Booker T. Washington, alumnus of the Hampton Institute, described Frissell as "one of the finest, most unselfish, and most attractive men that I have ever come into contact with…Under the clear, strong, and almost perfect leadership of Dr. Frissell, Hampton has had a career of prosperity and usefulness that is all that [the founder of the Hampton Institute] could have wished."[166] As written earlier, Frissell played a fundamental role in the investigation in establishing trust with the community. Bevier later wrote of Frissell: "I came away from Hampton Institute with a great admiration for the work that Dr. Frissell and his staff were doing, and for the way in which the colored people responded to their efforts. Over and over again they said to me, 'Hampton has done so much for us; we must do all we can for it.'"[167]

Frissell and Bevier conducted their study at a time in the era of the new Jim Crow regime in the South, and the citizenship status of African Americans was under fire. The Hampton Institute, alongside Booker T. Washington's Tuskegee Institute, had a mission of achieving equality for African Americans through vocational education or "racial uplift." In 1895, four years before the Hampton dietary study, Washington gave his famous speech—critically called the "Atlanta Compromise" by W.E.B. Du Bois—in which he asked Black southerners to "cast down your buckets where you are," and thus "seemingly trad[ed] the political demand of equal rights for economic opportunity."[168] Though these arguments were "predicated upon the possibility for black progress," as David Sehat has noted, in their criticism of "the black lower class, proponents of racial uplift made claims about black social mores that were […] 'uncannily similar to the racist

[165] "My Early Training," 1928, Bevier Papers, Box 14, University of Illinois Archives
[166] Booker T. Washington, *Up from Slavery: An Autobiography* (Toronto: William Briggs, 1901), 295.
[167] "My Early Training," 1928, Bevier Papers, Box 14, University of Illinois Archives.
[168] David Sehat, "The Civilizing Mission of Booker T. Washington," *The Journal of Southern History* 73, no. 2 (2007): 347.

arguments that they strove to refute.'"[169] Nutrition science was appealing to Booker T. Washington's belief in education for individual material and economic progress over other types of political reform. He corresponded with Edward Atkinson about food economy in the 1890s, and even purchased several of Atkinson's Aladdin Ovens for his school.[170] Washington also corresponded with Atwater, who invited him to speak at Wesleyan in 1895 and hosted Washington while he was in Connecticut. According to historian Molly Laas, the two men planned an Alabama dietary study during Washington's visit.[171]

The dietary study took place at the Tuskegee Institute in 1895, before Frissell and Bevier's study, and provides an example of the adoption of racist language in arguments for racial uplift through education. The study was conducted largely by a special agent of the USDA—H.M. Smith—who, in his section on "The Region and its People," criticized the research subjects as "lazy" and "ignorant," and even wrote, of the "evil" of the tenant farming system: "it seems probable that the shiftlessness and improvidence of the negro which inevitably accompany his ignorance are largely to blame." In line with the mission of Tuskegee, Smith wrote: "The cure will only come with education; this must be industrial as well as intellectual. The influence of such an institution as that at Tuskegee in this direction is most salutary and fortunate."[172] Tuskegee and Hampton had similar politics, yet, as we will see, the dietary study at Hampton had a different tone and conclusion. It is possible that this is because one of the coinvestigators of the Hampton study was intimately connected to the community – Hollis Frissell. Smith was an outsider from Washington who traveled to Alabama for the study. Indeed, another study conducted by Smith—of Italian immigrants in Chicago—similarly employed racial stereotypes in criticizing the dietary choices of the research subjects, and attributed their social condition to ignorance or stubbornness in dietary choices.[173]

Frissell and Bevier's dietary study in Virginia was divided into two parts: Bevier observed families of poor to moderate income living in Elizabeth City County, Virginia, while Frissell observed the diets of very poor African American families living on the edge of the Great Dismal Swamp, a swamp on the border of Virginia and North Carolina known for its history of harboring large maroon societies of people who had fled slavery.[174] On a daily round trip of fifteen miles on

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[169] Sehat, 351, 325.

[170] On nutrition and food economy, Atkinson wrote to Washington, "The more you put the colored man on the lead, the more surely will he obtain his right position politically and socially"—clearly complementing the bootstraps arguments that Washington made elsewhere. Atkinson to Booker T. Washington, April 26, 1895, Edward Atkinson Papers, Massachusetts Historical Society. Atkinson had been a strong supporter of abolition due to his economic ideology of free trade; he envisioned that in the post-slavery South, freedmen would work in cotton production for wages (rather than owning land.) DuPuis, *Dangerous Digestion*, 61–62.

[171] Laas, "Nutrition as a Social Question," 196.

[172] Atwater and Woods, *Dietary Studies with Reference to the Food of the Negro in Alabama in 1895 and 1896*, 19.

[173] Atwater et al., *Dietary Studies in Chicago in 1895 and 1896*, 15. It is worth noting that in the discussion of the Alabama study's results (presumably written by Atwater), Atwater acknowledged the limits of circumstances of the research subjects. "While the diet of the negro in the South is a very important factor of his character and condition," Atwater wrote, "its effect can hardly be separated from that of the other conditions of his existence" (64). Many historians and scholars understandably attribute all writing in these two bulletins to Atwater, as he is listed as one of the authors, but one might note that in both the Chicago and the Alabama study, the writing that is most often used to criticize Atwater's ethnocentrism was not written by Atwater. Of course, Atwater bore responsibility for printing Smith's or other investigators' racist views in his bulletins. Atwater and Woods, *Dietary Studies with Reference to the Food of the Negro in Alabama in 1895 and 1896*.

[174] For recent research on the Great Dismal Swamp, see: Daniel O. Sayers, P. Brendan Burke, and Aaron M. Henry, "The Political Economy of Exile in the Great Dismal Swamp," *International Journal of Historical Archaeology* 11, no. 1 (March 1, 2007): 60–97. The connection of the Great Dismal Swamp to maroon societies was well known at this

highways and plantation roads, Frissell visited twelve farming families over two months in 1897. The families lived in small board cabins "constructed in a very crude and simple manner" on land that was "low and swampy" where "malaria was exceedingly prevalent."[175] Frissell closely observed the constraints of the families' circumstances. "Nearly all of the families studied had very little means," he wrote. They each rented a "one-mule farm" and paid "a part (sometimes as much as one half) of their produce as rent. On the remainder of the produce, together with the income from what odd jobs can be obtained, the family must be supported."[176] The subjects received "rations" as payment for odd jobs. Many of the houses did not have access to clean water. For each farm, Frissell described the soil quality, which was mostly clay and some sandy, "poor and unproductive."[177] The low pay (often in rations), clay/sandy soil, and high rent figured prominently in the constraints of the families and manifested in the subjects who were described variously as "clothed in rags," "feeble," and "in poor health." One of the research subjects, an infant, died during the study.[178]

Bevier's part of the dietary study mirrored Goss's study. It included six families: three who lived on Butler's Farm, land that was given to freedmen by General Butler at the end of the Civil War, and three who lived in Hampton, including two families of moderate circumstances and one of poor circumstances. Bevier explained that in Elizabeth City County, the majority of African Americans worked in agriculture "Many own from 1 to 3 acres of land and two or three negroes own 40 or more acres" and one man owned one hundred acres. "Truck farming is a very prevalent occupation of the farming region," Bevier explained. "Early vegetables are raised in large quantities for the Northern market, and potatoes, peas, and sweet corn, as well as small fruits and berries, are shipped to Washington and other cities." In the town of Hampton, African Americans worked in a variety of trades:

> Negroes are painters, carpenters, shoemakers, blacksmiths, wheelwrights, masons, and plasterers…The negro professional men include physicians, lawyers, clergymen, and teachers, and one of the largest building and loan associations of

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time, as shown by its appearance in popular works in the nineteenth century, including: Harriet Beecher Stowe, *Dred: A Tale of the Great Dismal Swamp, Together with Anti-Slavery Tales and Papers, and Life in Florida after the War* (Boston and New York: Houghton, Mifflin and Co., 1896); Henry Wadsworth Longfellow, "'The Slave in the Dismal Swamp' (1866)," in *Poems of Places: America: Southern States* (Boston and New York: Houghton Mifflin Company, 1879), 67.

[175] Hollis Burke Frissell and Isabel Bevier, *Dietary Studies of Negroes in Eastern Virginia in 1897 and 1898* (Washington DC: Government Printing Office, 1899), 7.

[176] Frissell and Bevier, 8.

[177] Frissell and Bevier, 11.

[178] Frissell and Bevier, 14. The descriptors were used throughout the study. Rather than critiquing the poor, Frissell seemed to have the goal of exposing their impoverished conditions. Frissell described his subjects as working hard to get by in a harsh environment. All adults in all the families worked. Most worked on the farm or as hired labor, though one man worked as a teacher and one woman worked as a midwife. Adults who were sick or "lame" still worked, doing odd jobs if they could not do physical labor. Other clues imply that Frissell's study was more of an exposé than a critique. In his introduction, Frissell noted that "more or less opposition was manifested by the white population on the carrying on of these investigations among the negroes." His explanation for the opposition is not entirely clear: he wrote that it was "a difficult matter" to explain the goals of the investigation and "[t]here is a suspicion of interference, or some other prejudice is encountered" (7). While scholars have often portrayed the working-class dietary studies, and particularly the descriptions of the subjects' living conditions, as a way to portray the poor as inefficient and ignorant, Frissell's descriptions seem to be exposing the impoverished and harsh conditions of tenant farmers, in a similar way that Goss described the harsh conditions of tenant farmers in New Mexico. Note that this directly contrasts with characterizations by H.M. Smith in the dietary study in Alabama.

the State is managed by colored people. Life insurance and real estate agencies are also conducted by the negroes of Hampton.[179]

The houses "[varied] greatly according to [the family's] financial condition." The houses in Hampton, she noted, were "substantial and commodious homes, built according to modern ideas."[180] Bevier included photographs of the homes of research subjects to depict the different living standards (Figures 8- 9). Consistent with the arguments previous researchers, Bevier emphasized the influence of class position and education in shaping a person's living conditions.

U. S. Dept. of Agriculture, Bul. 71, Office of Expt. Stations. PLATE II.

FIG. 1.—HOUSE OF NEGRO BOOKKEEPER (DIETARY STUDY NO. 234).

FIG 2.—INTERIOR OF HOUSE OF NEGRO BOOKKEEPER (DIETARY STUDY NO. 234).

U. S. Dept. of Agriculture, Bul. 71, Office of Expt. Stations. PLATE III.

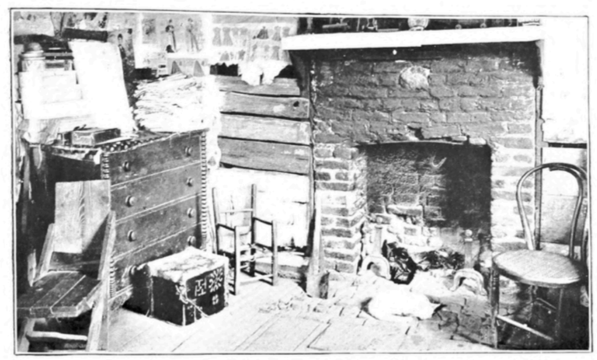

FIG. 1.—INTERIOR OF HOUSE OF NEGRO FAMILY (DIETARY STUDY NO. 237).

FIG. 2.—INTERIOR OF HOUSE OF NEGRO FAMILY (DIETARY STUDY NO. 239).

Figures 8 and 9: Similar to Goss's New Mexico bulletin, Bevier and Frissell included photographs of the homes of their research subjects to depict the change in living conditions. As the discussion below will note, researchers also emphasized the influence of the university on research subjects who had greater means. Hollis Burke Frissell and Isabel Bevier, *Dietary Studies of Negroes in Eastern Virginia in 1897 and 1898* (Washington DC: G.P.O., 1899, 1899): Plate II and III.

The study demonstrated that as one moved up the social ladder, the diet became more varied and more similar to that of white Americans in the Northeast. The families in the Great

179 Frissell and Bevier, 27–28.
180 Frissell and Bevier, 28.

Dismal swamp procured much food through hunting and fishing, eating mostly fish but also frogs, turtles, opossum, raccoon, muskrat, and snakes – foods that would have been unfamiliar and surprising in the urban Northeast.[181] In Hampton, the diets began to resemble more familiar fare. Bevier observed of a bookkeeper's family: "Food was bought in considerable variety, and, in fact, the dietary resembles that of an ordinary well-to-do white family."[182] Bevier recognized the limits on accessing a varied diet based on income, from inability to buy food in bulk and inability to store it. "Three of the families visited used ice. This is almost a necessity in any variety of food in used," she wrote.[183] Meanwhile, the farming families had a less varied diet and one that was more closely tied to their local environment. Almost all of the farming families studied had a vegetable garden and pigs and chickens, and half had a cow. "The negroes in the vicinity obtain their living almost entirely from the soil," wrote Bevier.[184] Bevier made one critique that demonstrated her bias towards a New England diet – she noted that the children in the study drank very little milk, and connected this to a possible lack of nourishment.[185]

Despite the critique of milk use, however, Bevier and Frissell actually concluded that the diets on average were generally nutritious and sufficient. Though their table showed a great deal of variability among the dietaries, the average more closely reached the standard protein requirement than any previous USDA dietary study.[186] The researchers wrote that this was "doubtless due to the close proximity of salt water, which made fish an important article of diet."[187] The research subjects also ate more calories than white Americans in other dietary studies, the investigators noted. Bevier and Frissell explained that the diet very nearly paralleled the diet of the Mexican families that Goss studied: "The character of the food materials was, however, widely different. The negroes lived largely on bacon, fish, and corn meal, the Mexicans on flour and frijoles, and other legumes, with very little meat."[188] Here they used chemical analysis to demonstrate that foods that looked and tasted different could have a similar nutritional value.

However, the researchers did not prescribe the Virginia dietaries for all American families. They wrote that though the dietaries were nutritionally valuable, "However, the food would certainly seem less appetizing and would not suit families used to more elaborate living."[189] Bevier often associated the taste and attractiveness of food to digestibility, and claimed that unattractive food was not easily digested.[190] After writing that African Americans in Virginia appeared to be better fed than other Americans—including than "the ordinary white person"—the bulletin read: "Of course, nothing can be definitely said regarding the digestibility of the diet. It seems quite certain that coarse food materials, like corn meal, are less digestible than the finer flours. Neither can anything be said concerning the effect of the preparation of the food and its attractiveness upon

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[181] Helen Zoe Veit describes the use of these foods as demonstrating the desperation of these families in an edited volume of primary sources. Helen Zoe Veit, *Food in the American Gilded Age*, American Food in History (Michigan State University Press, 2017), 167.
[182] Frissell and Bevier, *Dietary Studies of Negroes in Eastern Virginia in 1897 and 1898*, 31.
[183] Frissell and Bevier, 29.
[184] Frissell and Bevier, 8.
[185] Frissell and Bevier, 29, 41.
[186] "It is noteworthy that the average amount of protein in dietaries of negro families in Virginia was as large or larger than the average amount found in the daily diet of white persons in moderately comfortable circumstances, such as families of mechanics and families of professional men, and was very nearly as large as that called for in the tentative American standard, namely, 125 grams per man per day," they wrote. Frissell and Bevier, 40.
[187] Frissell and Bevier, 40.
[188] Frissell and Bevier, 41.
[189] Frissell and Bevier, 41.
[190] See Chapter 3 for a discussion of the role of taste in Bevier's bulletins.

its digestibility."[191] The bulletin sounded like that of a typical New England reformer, arguing that non-white fare was unattractive or poorly digested; yet in making this argument, it also went against the idea of asserting that all working-class people should adopt the most economical and efficient diet despite their food preferences.

In this way Bevier and Frissell differed from Goss, who wrote that Americans should learn from the diet of New Mexicans. While both studies showed the nutritional values of the diets and both studies made arguments about the ability of groups with greater means to be "Americanized"—by describing the ways that Mexican or African American professionals adopted similar living conditions as white American professionals—they differed in their conclusions. Goss concluded that Americans should learn from the efficiency of traditional Mexican diets, which could be seen criticizing the white working class for not adopting unfamiliar, but nutritionally valuable, foods like frijoles. Bevier and Hollis argued that the Virginia diet may be unattractive, which could imply that the diet, though nutritionally sound, was "uncivilized," or that workers should not be implored to adopt unfamiliar foods. It seems more likely that, in interpreting these conclusions, these researchers were not as concerned with the diet of the urban working class in the Northeast as they were with local concerns. Bevier and Frissell were clearly more interested in demonstrating the positive influence of the Hampton Institute, thus supporting the mission of economic uplift through education espoused by Hampton and Tuskegee. Thus, though the diets were nutritionally adequate, they could show the potential for Hampton to improve them. On the other hand, Goss may have been more interested in demonstrating the merits of the regional cuisine of New Mexico, a cuisine that was being portrayed as "uncivilized" and "unamerican" in debates over statehood. In both cases, the studies complicate the usual narrative of the relationship of non-white diets to nutrition science during this era.

Myer Jaffa's Study of Chinese Dietaries in California

In 1898, Myer Jaffa, professor at the University of California in Berkeley, took up the task of researching the diet of Chinese immigrants living in the Bay Area. This study not only fulfilled the national study's purpose of examining the diet of the working class for possible improvement, but also fulfilled Jaffa's objective as a professor at the University of California to study the products of California's rapidly developing horticultural landscape. Jaffa's bulletin on the Chinese diet in California also examined a group of fruitarians, and he explained that he chose these two groups because they might represent a largely vegetarian diet. As historian Sucheng Chan has described, Chinese immigrants in California largely ate a diet based on both fan (or grain) and choy (or vegetables). When the Chinese moved to California, Chan explains, they created vegetable gardens for their families, but soon began to sell vegetables to the general public. "Peripatetic Chinese vendors functioned as California's earliest group of retail distributors of fresh produce," Chan writes.[192] Chinese truck gardeners, whose "small vegetable gardens encircl[ed] the city [San Francisco] with one belt of greenness," peddled their products from door to door, and Jaffa clearly interacted with these produce vendors (Figure 6).[193] At the time of Jaffa's study, Chinese immigrants were playing a fundamental role in creating California's horticultural landscape, and a study of the Chinese diet had the potential to promote the products of this

[191] Frissell and Bevier, *Dietary Studies of Negroes in Eastern Virginia in 1897 and 1898*, 41..
[192] Sucheng Chan, *This Bittersweet Soil: The Chinese in California Agriculture, 1860-1910* (Berkeley: University of California Press, 1989), 87.
[193] Quoting Henryk Sienkiewicz, Chan, 104.

landscape. Jaffa made this motive clear when he wrote to the California State Board of Horticulture in 1902, asking them to contribute to his studies: "Fruit is considered by the majority of persons as an accessory or supplementary food, taken for its agreeable flavor or hygienic or medicinal virtues rather than as a staple article of diet." Yet, he wrote, the abundance of fruit produced in California had allowed Californians to make it a staple article of diet. "Fruits and nuts have a high dietetic value," Jaffa argued, "but without scientific data to that effect we cannot make the general public take cognizance of the fact."[194] What better way to demonstrate their value than to study groups that lived primarily off of these horticultural products?

Jaffa set out to conduct this study in a similar political landscape as Goss's New Mexico study, in which exclusionists were arguing against the idea that Chinese immigrants could become citizens. The anti-Chinese sentiment during this period resulted in the continued passage of the Chinese Exclusion Act in 1902. Much of the anti-Chinese sentiment stemmed from white, nativist labor groups, who often argued that new immigrants were surviving on meager rations and thus able to work for lower wages, undercutting American workers. They feared that these immigrants would degrade the living conditions of American workers. Food played a prominent role in these arguments. In "Meat v. Rice: American Manhood Against Asiatic Coolieism," a pamphlet that argued for the renewal of the Chinese Exclusion Act in 1902, labor organizers Samuel Gompers and Herman Gutstdt made this exact argument, quoting Maine Senator James Blaine: "You cannot work a man who must have beef and bread alongside of a man who can live on rice. In all such conflicts, and in all such struggles, the result is not to bring up the man who lives on rice to the beef-and-bread standard, but it is to bring down the beef-and-bread man to the rice standard."[195] The title itself represents the use of food in politics and identity, placing at the forefront the fear of working-class white Americans of losing access to meat and being forced to consume foreign foods, which, according to the pamphlet, would degrade both their standard of living and their masculinity.

In the introduction to his bulletin, Jaffa described how many people assumed that the Chinese, and Asians generally, lived "almost entirely upon rice." Jaffa had various reasons to suspect that this assumption was not true. First, he wrote, studies of other Asian groups such as the Japanese had demonstrated that rice was used in the same way that cereals and breads were used by the "Western races," as a staple eaten with a variety of other foods. Second, he observed that the Chinese workers in California were able to perform labor-intensive tasks. "Whatever the diet of the Chinese in America," he wrote, "the presumption is that it must be suited to their needs and must supply the energy necessary for a large amount of physical work. No Californian can doubt that the Chinaman is capable of great physical exertion, for it has been clearly demonstrated." Few Americans could walk with the massive produce baskets up and down the hills of the San Francisco Bay Area as the Chinese produce peddler did, Jaffa argued.[196] The ability to perform these tasks could not entirely be attributed to training and inheritance, he claimed: "at all events there is a great amount of energy required and it must necessarily, like all energy for the work done by the body, come from the food eaten. And what is that food?"[197]

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[194] Jaffa to J.J. Keegan, Secretary of State Board of Horticulture, December 3, 1902, Jaffa Papers, Bancroft Library.

[195] Samuel Gompers and Herman Gutstadt, *Meat Vs. Rice: American Manhood Against Asiatic Coolieism, which Shall Survive?*. American Federation of Labor (1902), 22.

[196] Jaffa, *Nutrition Investigations among Fruitarians and Chinese*, 35.

[197] Jaffa, 25–26. Some of Jaffa's language in this part of the bulletin lent itself to arguments for a racialized labor system. He wrote: "While it is generally conceded that a strong white man accustomed to the same kind of work can do 20 percent more work than a Chinaman where the conditions are favorable, it has been found that under adverse

Like Bevier and Goss, Jaffa studied Chinese Americans with various social statuses, including a dentist's family, laundry workers, and truck farmers. Unlike Bevier and Goss, his research subjects were immigrants or first generation, and when he described the relationship between Chinese and American cuisine, he was able to observe culinary conservatism with migration as well as social mobility:

> It is generally true that diet is modified by the environment, and it seems probable that although they are conservative in such matters, the Chinese in the United States have, to some extent at least, adopted American food habits. But that the bulk of the food is Chinese is shown by a visit to Chinese markets in any American city where these is a considerable colony of them.[198]

Jaffa found that though Chinese foods unfamiliar to Americans appeared at all levels of society, the diet of the Chinese truck farmers most closely adhered to Chinese cuisines. As researchers found with other immigrant groups, "the influence of former dietary habits was less marked the longer the residence in this country." Jaffa also connected difference in culinary conservatism to a rural/urban divide, writing that the truck farm laborers "living in the country were less affected by American food habits than those living in the city."[199]

Jaffa found similar results as Goss and Bevier in studying the three dietaries, and argued that all three diets were healthful. He argued that the diet of the truck farmers was both more nutritious than the typical diet of white laborers and procured at a lower cost. While Goss, Bevier, and Jaffa all demonstrated the ability of their various groups to adopt "American" food habits, thus weighing in on debates over statehood, citizenship, and immigration policy that hinged on the ability of certain groups to become "Americanized," they also pointed to the value of non-"American" (i.e. non-Anglo) foods. Jaffa did not portray the conservatism of the truck farmers as a negative.

While Goss and Bevier also used chemistry to demonstrate the value of non-white diets, Jaffa was explicit in his argument for the value of these diets in contrast to the biases of his audience. While other chemists entered the homes of their subjects to observe their health, living conditions, and collect data on the foods they ate, Jaffa shared meals with his subjects (with his colleague W.N. Fong of the Oriental languages department at the University of California, who translated during the meals). In sharing meals with his subjects, and providing photographs of the event, Jaffa actively demonstrated that unfamiliar, foreign foods were not to be feared.[200] Both in his eating of the foods and descriptions of how families "relished" the meals, he made the argument that the foods were not only nutritious, but appetizing. Jaffa directly addressed the negative stereotypes of Chinese diets, writing that they were "neither scanty nor inferior." He emphasized:

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circumstances, such as long hours, great heat, or exposure to cold and dampness, a Chinaman can not only do more work, but can stand the strain better" (26).

[198] Jaffa, 26. The use of the word "colony" is typical of people writing about Chinese immigrants at the time, though it certainly has a racist, dehumanizing tone.

[199] Jaffa, 38.

[200] Though exclusionists often wrote about the "scanty" Chinese diet during this period, this period is also associated with the birth of Chinese American cuisine and the rise of Chinese restaurants in the United States. Of course, Jaffa was not eating at a restaurant – he was sharing a meal in the home of the truck farmers. But the rise in popularity of this cuisine demonstrates that Jaffa was not alone in his arguments about unfamiliar foods being appetizing. See: Andrew Coe, *Chop Suey a Cultural History of Chinese Food in the United States* (New York: Oxford University Press, 2009); Anne Mendelson, *Chow Chop Suey: Food and the Chinese American Journey*, Arts and Traditions of the Table : Perspectives on Culinary History (New York: Columbia University Press, 2016).

"Many of the food[s] eaten were unfamiliar to most Americans, but nevertheless can not be regarded as other than wholesome and nutritious."[201] Jaffa was more overt than Goss and Bevier that he sought to learn from the diets. While all of the chemists explained that the dietary standards were up for debate, Jaffa explicitly said that the purpose of studies was to *build* standards by looking at diverse groups (in his case, specifically looking at vegetable-based diets).

Discussion

All three dietaries examined non-white diets at three levels of society, and all three studies made arguments about how these groups became "Americanized" when they had greater means—which gave them access to more variety in their diet—while also using chemistry to argue for the value of the foods unfamiliar to white Americans in the Northeast. In making arguments about Americanization, Goss and Bevier may have also been demonstrating a positive influence of the agricultural colleges—as the families of greater means had closer connections to the university. This was especially the case in Bevier's study. She explicitly stated that the purpose of looking at families at three levels of society was:

> In order to obtain more definite information concerning the effect of education and other improving factors upon the character and amount of the food consumed by the negro, studies were made in families in widely different circumstances. Some of the families were in comfortable circumstance, others had very limited incomes. Some had been brought to a great degree under the influence of the Hampton Institute, others had not had the benefit of such training.[202]

In the study, she noted, for example, that "Two of [the families living in Hampton] showed in a marked degree the beneficent influence of the neighboring Hampton Normal and Agricultural Institute, where they had received education and industrial training." Their "substantial" homes were built by the "school carpenters" and "the housekeeping was carefully attended to and considerable attention given to the selection of food." This also made a case for the importance of domestic science education, which historian Harvey Levenstein has argued was a primary motive in home economists conducting dietary surveys.

Goss and Jaffa's studies also demonstrate how the particular goals of the agricultural colleges in the West shaped the surveys. Goss provided a detailed description of the New Mexican environment, that resembled typical Western boosterism of the era. Though he wrote that the "exceedingly dry" climate of Las Cruces may have made the agricultural landscape seem "utterly worthless," he emphasized the ability of the land to produce food: "wherever there is sufficient water, either in streams or springs, grass is abundant, and under the influence of the summer rains plains that were apparently entirely bare will turn green and become valuable pasture land in a very short time. Even the seemingly dry barren mesa produces much valuable forage and supports large numbers of sheep and cattle throughout the entire year."[203] Jaffa's study perhaps most obviously was meant to serve the farmers of his state, as he explicitly stated that he sought to show the value of fruits and vegetables in the diet—foods that were typically viewed as accessories and not dietary staples, and that defined California's horticultural landscape during this era.

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201 Jaffa, *Nutrition Investigations among Fruitarians and Chinese*, 43.
202 Frissell and Bevier, *Dietary Studies of Negroes in Eastern Virginia in 1897 and 1898*, 27.
203 Goss, *Nutrition Investigations in New Mexico in 1897*, 8.

The three dietaries also all studied rural populations, and this might be one of the most important reasons for why they differed in their conclusions from the urban working-class studies. The people near the Great Dismal Swamp and on Butler's farm, the Chinese truck farmers, and the Mexican tenant farmers all grew, raised, hunted, or fished for a large portion of their food. It is difficult to understand how the researchers factored this into their assessment of the cost of their diet.[204] The researchers did not directly comment on this, but in some ways the dietary studies might show how the rural poor were better fed than the urban poor because of their access to land. Bevier and Frissell come closest to commenting on this in their conclusion that the protein intake was high in their study because of access to fishing. This observation is not meant to romanticize work with the land; one can imagine that some urban dwellers may have preferred to purchase their food than to farm, raise, hunt, fish, and forage for their food (and in fact may have left the farm for that reason). Yet, there were also many people, including African Americans in the South, recent immigrants, and other rural people, who *did* in fact want to own land and practice subsistence farming, and faced a number of barriers to land ownership during this period. Although more work needs to be done on this question, these dietary studies suggest that disconnection from land led to a more strained diet among urban working-class people when compared to their rural counterparts.

Several newspapers covered Jaffa's and Bevier and Frissell's studies and wrote sensationally about the spectacle of scientists studying the diets of poor, non-white people while presenting racial stereotypes and misinterpreting conclusions. Under the headline "Negro Diet of Snakes: Queer Things Eaten in Region of Great Dismal Swamp," a *Washington Post* article called the inhabitants "barbarian" and "savage" and claimed that the Virginia diets were inefficient due to "defective culinary methods." The article mirrored the claims made elsewhere about Chinese immigrants and poor New Mexicans being able to live on almost nothing. It began: "It has always been taken for granted that a genuine swamp darky could masticate anything, from horse-shoe nails and billy-goat tin cans up to elephant hide, but not even a scientist supposed that he could digest half-cooked snakes in the wholesale fashion that prevails around the region of the Dismal Swamp." The article wrote that the "dusky inhabitants" were "almost savages," as "snakes, snapping turtles, and eels form the chief articles of [their] diet, and these are rarely well-cooked." This directly contradicted the study itself, which did not list these as the chief staples of the diet (instead "hog and hominy" formed the foundation of the diet). Though the article quoted the bulletin extensively, it ended with a quote by an outside physician, perhaps as a way to undermine the study's conclusion that the diets in fact met nutritional standards as well as, if not better than, that of other working-class groups. The physician claimed: "Judged by its quantity and quality, the food of the Virginia negroes is amply sufficient, but it loses in value from its indigestibility and the defective culinary methods by which it is prepared."[205] The article characterized the diets as uncivilized and made the claim that the culinary methods and digestibility of the foods in fact made the diet inferior.

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[204] Their assessment of cost is not well explained in the bulletins that I have examined. It does appear that they were calculating a monetary "cost" for foods that families grew or raised, as the tables include a monetary value for every item listed, even when it is clear the food item came from the research subject's own garden or farm animals (for example, the tables listed a cost for eggs for families that owned a large number of chickens). It is unclear where these costs come from, and whether the costs are accounting for the time and labor of raising farm animals or a home garden. I have not found a bulletin directly addressing this, despite the researchers recognizing the importance of these procured foods for their rural research subjects, and despite them comparing costs between the rural and urban poor.

[205] "Negro Diet of Snakes," *The Washington Post*, August 5, 1900.

A *Sunday Call* article on Myer Jaffa's study of the Chinese diet also presented racist stereotypes and more drastically misrepresented the study's conclusions. The journalist wrote in shock that few college professors would "voluntarily inflict their palates with Chinese fare," and that "Professor Jaffa is probably the only man in college or out who for three weeks broke bread with almond-eyed aristocrats who 'do washee velly cheap' and sell vegetables 'velly fresh, velly good.'" Moreover, the journalist claimed that the Chinese diet was largely vegetarian and thus a "serious detriment to their physical development." This directly contradicted Jaffa's finding that "generally speaking the Chinamen lived very well compared to white people doing the same sort of work. The amount of work they did, and their health, proves that their dietary contained an ample amount of nutrition." [206] Both the *Washington Post* and the *Sunday Call* used the studies to reinforce racist stereotypes while missing each study's overall conclusion.

A few newspapers, however, covered the studies in a way that more closely matched the conclusions of the researchers. *The Sunday Examiner*, for example, recognized Jaffa's conclusion that the Chinese diet was the most nutritious at the lowest cost of all the working-class groups studied as part of the national survey. [207] *The Chicago Tribune*'s coverage of the Virginia study also starkly contrasted with the above media coverage. "Dietary studies made by the Department of Agriculture among negro families in eastern Virginia show that the average fuel value of the food consumed is as large or larger than among white families in moderate circumstances in New York and New England," the article read. "Another strange fact developed is that the negro can live much more cheaply than the average white and yet get as much real benefit from his meals." The article directly quoted the study in writing that the diets may not be appetizing to families "used to more elaborate living," but it also emphasized the diets' merits, and captured perhaps the most important conclusion the nutrition scientists in this era were trying to promote: foods of different taste and character can have the same nutritional value. The *Tribune* wrote: "The average food consumption found in four native Mexican families resident in New Mexico resembles quite nearly, as regards to protein and energy, the food consumed by the negroes in Virginia," and directly quoted Bevier that though the character of foods were different, they were nutritionally equivalent.[208]

III. Conclusion: A Growing Divide

Chemists conducting the dietary surveys frequently made suggestions on how the various diets could be improved; but in many of the bulletins, it is clear that the chemists were generally more interested in learning from their observations with an eye towards adjusting nutritional

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[206] "California College Professor Tries the Diet of John Chinaman," *The Sunday Call Magazine*, April 29, 1900, Jaffa Papers, Volume 1, Bancroft Library.

[207] "United States Is Telling Nations What to Eat," *Sunday Examiner Magazine*, July 29, 1900, Jaffa Papers, Volume 1, Bancroft Library.

[208] "Urged to Pass Treaties." *Chicago Daily Tribune,* January 22, 1900. The contrasting ways that the media covered the studies might shed light on the way that the studies have been interpreted in the current historiography. It might be that multiculturalist arguments in the studies were looked over at the time by an audience more interested in difference. In her history of New Mexico, Linda Noel describes of the depiction of New Mexico in the media that supports this idea. She discusses how Governor Otero of New Mexico "complained repeatedly about visiting easterners…who remarked upon every adobe building while remaining oblivious to the region's modernization." She notes, "Otero's grumbling about the East's fascination with 'difference' was apt, as magazine articles of the era visually depicted Arizona and New Mexico as places lacking modernity by showing only decrepit adobe structures, creating an image of the territories backwardness and inferiority." Noel, *Debating American Identity*, 37–38.

standards than in imposing dietary standards on various groups.[209] Even Atwater himself "saw his dietary standard as a rough heuristic," historian Molly Laas notes. "It was obvious to him that the vagaries of age, gender, occupation, and other conditions of living affected dietary requirements to a degree that rendered his calculations into a general guideline at best."[210] In their bulletins, agricultural chemists and domestic scientists often commented on the newness of the scientific field and the gaps in the knowledge that their surveys might help fill. Edwin Ladd of the University of North Dakota, for example, conducted one of the few dietary studies that solely examined women subjects, and he noted that thus his study "should prove of considerable interest."[211] Ladd wrote that it was popularly believed women had different fat-protein-carbohydrate needs, but in his study, he found that the female students ate a similar ratio of nutrients as male students studied elsewhere.[212] Though they seemed to be eating too little protein according to the standard, Ladd wrote that the students appeared to be healthy and "it would be unfair to assume from the limited data available that the North Dakota students were not receiving all the food they needed."[213] As described earlier, Myer Jaffa similarly began his study of the Chinese diet and of the fruitarian diet (discussed in Chapter 3) noting a gap in nutritional knowledge–the assumption that fresh fruits were "accessory foods" rather than staple articles of the diet. "Perhaps for this reason very little scientific study has been given to fruit as compared with the investigations which have been carried on in connection with other more common food materials," Jaffa noted. "Chemical analysis has shown the comparative composition of fruits, but our knowledge of their dietetic value, digestibility, and comparative cost as sources of nutrients is far from being complete."[214] As we will see in Chapter 3, Jaffa and other chemists used their observations in the dietary surveys particularly to challenge scientific evaluations of fresh produce during the period. Jaffa, Ladd, and other researchers showed that they were learning from their observations during the dietary surveys. As noted earlier, Atwater even used dietary studies to argue for a higher nutritional standard—and particularly a higher protein standard—than the widely adopted Voit dietary standard.[215]

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[209] When Atwater raised his dietary standards, Atkinson recognized that Atwater believed that Americans "ought to live on a higher nutritive plane" but largely emphasized that the higher standards were because Americans were more wasteful in their cooking than Europeans. He wrote: "If nutrition could be governed by exact and scientific rules under uniform conditions all these standards could be much reduced, but such conditions are not to be expected. The standards may therefore be said to be loaded with a large margin for the waste, particularly of people who are intelligent and purely economical. /Again, these standards must be raised to meet the gross waste of ignorant people and the very bad cooking habits which prevail." Edward Atkinson, *The Science of Nutrition*, 4th edition (Boston: Damrell & Upham, 1896), 147.

[210] Laas, "Nutrition as a Social Question," 185.

[211] Isabel Bevier and Elizabeth C. Sprague, "Dietary Study at Lake Erie College, Painesville, Ohio," in *Nutrition Investigations at the University of Illinois, North Dakota Agricultural College, and Lake Erie College, Ohio, 1896 to 1900* (Washington DC: Government Printing Office, 1900), 21.

[212] Atwater noted that his assessment that women needed .8 the energy required of men was a rough estimate mainly based on body size. Laas, "Nutrition as a Social Question," 184. This estimate is fairly close to the standards used today. In the 2020-2025 USDA dietary guidelines, they recommend women aged 19-25 years old (the age that Ladd studied) consume about 78% of the number of calories they recommend for men of the same age. https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf

[213] Bevier and Sprague, "Dietary Study at Lake Erie College, Painesville, Ohio," 25.

[214] Jaffa, *Nutrition Investigations among Fruitarians and Chinese*, 7.

[215] Atwater argued that even if men could live by a lower standard, it did not follow that a lower standard would be optimal for health. He wrote: "The thesis which I attempt to defend is that to make the most of a man…to enable him to live as a man ought to live, he must be better fed than he would be by these standards. The principle is one that reaches very deep into the philosophy of human living." Laas, "Nutrition as a Social Question," 136.

Atwater's use of observations to create higher dietary standards sparked a noteworthy critique from a leading physiological chemist at the time – Russell Chittenden. As other scholars have discussed, Chittenden believed that data collected from observation could not be used to understand the laws of nutrition.[216] In 1904, he wrote of the dietary surveys that "there is no evidence whatever that they represent the real needs or requirements of the body."[217] He asked, "How far can our natural instinct be trusted in the choice of diet?" Human beings were "creatures of habit" whose palates are "excited by the rich animal foods." "[W]e may well question," he argued, "whether our dietetic habits are not based more upon the dictates of our palates than upon scientific reasoning or true physiological needs."[218] Chittenden conducted his own series of laboratory experiments in which he attempted to prove that men could live healthily on a low protein diet. In response, Francis Gano Benedict, Atwater's protégé, repeated Atwater's argument that when men had access to protein they ate it liberally. "It certainly seems more than a remarkable coincidence that peoples varying so widely in regard to nationality, climate and geographical conditions […] should show such agreement," Benedict claimed.[219] As another physiologist similarly wrote, if Chittenden were right about his low protein standard, "all the world up to this time, with the exception of a few faddists, has been wrong."[220]

Chittenden also differentiated himself from other chemists in his interest in finding a *minimum* dietary standard. Molly Laas has highlighted that Atwater was not interested in making standards for minimum requirements; he was, in fact, aware that man could live on a lower protein intake than what he recommended. Atwater was instead interested in creating standards that would "make the most of a man," Atwater wrote. "[T]o enable him to live as a man ought to live, he must be better fed than by [the European] standards."[221] Chemists conducting the dietary investigations shared Atwater's view. In his study of fruitarians (which will be discussed in Chapter 3), Myer Jaffa found that his subjects were able to live healthily on a low protein diet, but he wrote that even if it could be proven that people could live on a low protein diet, "it would still be a great question of whether or not it would be wise to do so." Jaffa noted that it was possible that the negative impacts of a low protein supply "might be slow in manifesting themselves, but might also be serious and lasting." Chittenden believed that Atwater and Jaffa were not considering that consuming *too much* protein might be harmful to health. He cited Jaffa's study at length to support his own argument for a low protein standard, and wrote that Jaffa, in his cautious conclusion, was not considering the potential negative impact of a surplus of food on the body. "To an unprejudiced observer, one not wedded to old-time tradition, it would seem as if great effort was being made to sustain the claims of a high-proteid intake," Chittenden argued. "It is surely well to be careful, but it is certainly not necessary to magnify imaginary dangers to the extent of suppressing all efforts toward the establishment of possible physiological economy." His implication that Jaffa was "wedded to old-time tradition" matched his earlier arguments that dietary traditions, habits, or instincts could not be trusted.

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[216] Laas, 205–7; Carpenter, *Protein and Energy*, 107–18; Neswald, "Nutritional Knowledge between the Lab and the Field," 41–45.

[217] Russell Henry Chittenden, *Physiological Economy in Nutrition, with Special Reference to the Minimal Proteid Requirement of the Healthy Man; an Experimental Study* (New York: F.A. Stokes Company, 1904), 3. He wrote elsewhere that by this line of argument, one might argue that tobacco or wine was also a physiological necessity. Russell Henry Chittenden, *The Nutrition of Man* (London: William Heinemann, 1907), 159.

[218] Chittenden, *Physiological Economy in Nutrition*, 8.

[219] Quoted in Carpenter, *Protein and Energy*, 133.

[220] Quoted in Carpenter, 114.

[221] Quoted in Laas, "Nutrition as a Social Question," 136.

Historian Elizabeth Neswald has convincingly argued that at the heart of Chittenden's criticism was a rejection of the field approach to studying nutrition and a favoring of the laboratory approach, an approach that would subsume the field-research approach. Of course, nutrition scientists generally combined both approaches. Though Chittenden clearly trusted laboratory experimentation over dietary observations to create physiological laws of nutrition, he also used dietary surveys such as Jaffa's to support his nutritional theories. Though they worked on dietary surveys, Atwater and Benedict might have been more similar to Chittenden in a preference for laboratory research as well.[222] Atwater saw the scientific value of the dietary surveys, as discussed earlier, but he devoted most his time and energy to the laboratory. He argued that there was "a great need for abstract inquiry," and that "the kind [of research] which reveals the fundamental laws of biological chemistry requires the atmosphere and the appliance of the university."[223] Between 1902 and 1904 (when Atwater suffered from a debilitating stroke), Atwater began working with the Carnegie Institution to establish a nutrition laboratory—the first laboratory solely devoted to the study of human nutrition—as the Storrs station discontinued its work in human nutrition. In 1907, Francis Gano Benedict became director of the Carnegie Nutrition Laboratory and began working to build an international research community, as Neswald has chronicled in another article. With this move to the Carnegie laboratory, "Benedict shifted the research focus from Atwater's study of diet and individual and social welfare to the highly technical, apparatus-based, and specialized field of metabolism research and its clinical applications."[224] Laas concludes her discussion of Atwater by noting that that in the early twentieth century, Atwater's framing of nutrition as a social question – which combined observational and laboratory approaches—declined in favor of a more narrow basic-research, quantitative, laboratory approach to the science.[225]

While the Storrs Agricultural Experiment Station may have discontinued work in human nutrition around 1902, other agricultural colleges and experiment stations did not.[226] There is an element of "nutrition as a social question" that was particularly important to scientists in these institutions - the relationship of nutrition science to food producers, and particularly to farmers. As seen in the dietary surveys, the unique geographical, institutional, and political context of scientists shaped their approach to studying nutrition. In their surveys, these scientists were not solely interest in uplifting the urban working class through nutrition education. Their surveys took place in the context of political debates over race, citizenship, and "Americanization," and their studies presented both assimilationist and pluralist arguments. The scientists studied the particular

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222 Molly Laas wrote of the debate between Chittenden and Atwater/Benedict, "It was possible that Atwater and Chittenden would have come to some accord." She noted that Atwater had written to the Carnegie Institute that he thought the laboratory should do work similar to Chittenden's experiments, and that there were plans being made for a collaboration between the two scientists at the Carnegie laboratory. Laas, 206.

223 Atwater, "The Economy of Food," 190.

224 Elizabeth Neswald, "Strategies of International Community-Building in Early Twentieth-Century Metabolism Research: The Foreign Laboratory Visits of Francis Gano Benedict," *Hist Stud Nat Sci* 43, no. 1 (2013): 8–9.

225 Laas summarizes several changes that contributed to this decline in her concluding pages on Atwater, including vitamin research and war. She writes that Atwater's framing of nutrition as a social question may have lost relevance during this period.

226 Neswald writes that "the Storrs station decided to withdraw from nutrition research to concentrate on its agricultural mandate in 1902." Neswald, "Strategies of International Community-Building in Early Twentieth-Century Metabolism Research: The Foreign Laboratory Visits of Francis Gano Benedict," 8. Laas writes, "in 1907 Benedict moved Atwater's old laboratory to the Carnegie Institution's new nutrition laboratory in Boston, though Atwater's calorimeter was sent to C.F. Langworthy's laboratory in the new USDA building in Washington." Laas, "Nutrition as a Social Question," 204.

foods produced and used in their state, and, especially in the case of Myer Jaffa, saw the potential for nutrition science to promote the farm products of their region. As state-funded scientists at this time, they were necessarily applied scientists, but they framed their observations in the surveys as contributing to a nascent scientific field.

Laas and Neswald have aptly noted the shift from Atwater's nutrition research at the Storrs station to Benedict's work at the Carnegie Nutrition Laboratory as a shift from a social framing of the science to a focus on abstract inquiry and highly technical approaches. To Benedict, Atwater "mixed horribly his abstract science and his ethics."[227] Though the move to the Carnegie Nutrition Laboratory was a "significant advance for basic research," as Naomi Aronson has noted, "most American nutrition investigators worked in the agricultural experiment stations, and their work continued to be influenced by the demands of this environment."[228] Not all chemists were turning away from an interest in the social, political, and ethical position of nutrition science. Chemists at agricultural colleges and experiment stations –especially two chemists who conducted dietary surveys, Myer Jaffa and Edwin Ladd—would in fact hit their stride in using the science to make ethical, political, and social arguments in the new debates over regulating "pure" and "artificial" foods.

[227] Quoted in Laas, "Nutrition as a Social Question," 204.
[228] Aronson, "Social Factors in the Development of Nutrition Studies: 1880-1920," 34.

Chapter 2: Counterfeit Food and the Ethics of Digestion
Nature, Science, and Populism in the Pure Food Movement

As chemists collected dietary data in farmhouses and tenements for the USDA surveys, a heated debate was growing among American food scientists. It began in the 1870s with a new product developed in France that, depending on whom you asked, represented either the achievements of modern food chemistry or the most threatening food fraud in American history, with the potential to degrade both the health of consumers and the livelihood of farmers. Oleomargarine—a product of laboratory experiments with beef tallow amidst wartime butter shortages in France—spurred a debate over the very definition of food and the accelerating industrialization of the American food system. This debate grew to encompass a multitude of new processed and imitation foods, from glucose to bleached flour to chemical preservatives, as scientists, citizens, and congressmen disputed the need for these foods to be regulated at the federal level. These arguments, which would culminate in the Pure Food and Drug Act of 1906, reveal the contentious nature of early American nutrition science, as chemists divided by geography, discipline, and institution in their scientific understandings of wholesome food.

This divide reached the top chemists in the USDA: Wilbur Atwater, the chief of the USDA's first nutrition investigations (Chapter 1), and Harvey Wiley, the head of the Bureau of Chemistry, for whom the Pure Food and Drug Act would be named.[229] In his first popular article on nutrition in 1887, Atwater devoted a section to combatting the stigma against the new spreadable product. "This is a case where mechanical invention aided by science is enabled to furnish a cheap, wholesome, and nutritious food for the people," he wrote. "The attempt to curtail or suppress the production of a cheap and useful food material by law […] is opposed to the interests of a large body of people, to the spirit of our institutions, and to the plainest dictates of justice."[230] In the same year that Atwater wrote passionately in favor of the product, Wiley expressed his doubts about its merits. "While it is true that chemical analysis and certain digestive experiments have not hitherto shown that pure butter possesses any marked superiority over butter surrogates," Wiley wrote in a bulletin on food adulteration, "it must not be forgotten that butter has a much more complex composition than lard or tallow or cotton-seed oil; that it is a natural food, and doubtless possesses many digestive advantages which science has not yet been able to demonstrate."[231] This disagreement represented a more general divide that would endure throughout the pure food debates: on one side were "pure" chemists like Atwater who worked in laboratories on the East Coast and scientists who worked for manufacturers, and on the other side were agricultural chemists largely working at land-grant colleges in the mid to far West (Wiley

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[229] The title of this chapter--"the ethics of digestion"--is a reference to a speech that Harvey Wiley gave in 1907, in which he described the Pure Food Movement as "Only the application of ethics to digestion and therapeutics. This is the new philosophy, namely, the morals of metabolism." This speech is quoted in John Harvey Young's 1968 article on Wiley. James Harvey Young, "The Science and Morals of Metabolism: Catsup and Benzoate of Soda," *Journal of the History of Medicine and Allied Sciences* 23, no. 1 (1968): 88–89. Wiley was appointed chief chemist of the USDA in 1883. He began teaching chemistry at Purdue in 1874, and after studying for a period in Germany, he served as Indiana's state chemist. His first work as state chemist was in regulating commercial fertilizers (as was the case with many state chemists), and in 1881, he published an article on the fraudulent use of glucose. He was appointed chief chemist largely due to his work analyzing sugar. James Harvey Young, *Pure Food: Securing the Federal Food and Drugs Act of 1906* (Princeton, NJ: Princeton University Press, 1989), 100–103.

[230] Wilbur O. Atwater, "The Chemistry of Foods and Nutrition. I.," *Century Illustrated Magazine*, May 1887, 59.

[231] Harvey W. Wiley, *Foods and Food Adulterants. Part First: Dairy Products*, Bulletin 13 (Washington DC: Government Printing Office, 1887), 24.

started his career exposing fraud as State Chemist of Indiana at Purdue University).[232] While the pure and manufacturing chemists expressed certainty that oleomargarine was a wholesome product of scientific advancement, the agricultural chemists expressed skepticism of the state of scientific knowledge, and of the impact of artificial foods on both public health and the food system.

Few historians have examined the epistemological debate that took place between pure/manufacturing chemists and state agricultural scientists in response to the rise of new manufactured foods and the movement to regulate them in the late nineteenth and early twentieth centuries. The general histories of the Pure Food Movement tend to fall into two narratives: One narrative, exemplified by the social historian Lorine Swainston Goodwin, highlights the movement as a consumer crusade, in which journalists and women's groups led the charge to expose corruption and fraud and create a safer food system.[233] The other narrative, such as that of the economic historians Clayton A. Coppin and Jack C. High, portrays the campaign as a technocratic, bourgeois, progressive movement that ultimately gave unnecessary power to the federal government.[234] Challenging the idea that the campaign was a grassroots movement, scholars in this line of narrative frequently point to how large food corporations ended up supporting and benefitting from the 1906 act.[235] In his comprehensive and foundational history of the Pure Food Movement, James Harvey Young observed that two kinds of voices arose for the cause that seem to mirror the two narratives that have emerged since his book was published: the reform voice, which focused on consumers and food safety, and the business voice, which, Young explains, "speaks in less frenetic tones, downplays danger, exempts from regulation harmless adulterants sanctioned by long trade practice, and defines more serious secret adulteration as a morally indefensible economic practice."[236] Yet neither voice quite captures the position of agricultural chemists, who spoke with the reform voice while advocating for food producers, and perhaps for this reason, neither historical narrative adequately captures the debate within the scientific community on how to define food safety standards in the emerging industrial food system.

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[232] In this chapter, I use the terms "state agricultural chemists" and "pure/industrial chemists" to distinguish between these two groups, but it is worth noting that that this time, a few of the "pure" chemists who worked on food, including Wilbur Atwater, were also "agricultural chemists."

[233] Lorine Swainston Goodwin, The Pure Food, Drink, and Drug Crusaders, 1879–1914 (McFarland, 2006).

[234] This work is often written by economic historians who argue in favor of free-market theories. Clayton A. Coppin and Jack C. High, *The Politics of Purity: Harvey Washington Wiley and the Origins of Federal Food Policy* (University of Michigan Press, 1999). See also: Ruth Dupré, "'If It's Yellow, It Must Be Butter': Margarine Regulation in North America Since 1886," *The Journal of Economic History* 59, no. 2 (1999): 353–71. Goodwin's and Coppin and High's books make opposing claims based on different sources and research questions. Focusing on women's groups, Goodwin argues that the Pure Food Movement was a grassroots movement in which women used lobbying, letter writing, speeches, pamphlets, journals and exhibitions to sway public opinion and pressure Congress to act. High and Coppin argue that it was a top-down movement, largely stemming from Wiley, who wanted to enlarge his own position. According to them, the food law was the product of the work of scientists, officials, and manufacturers rather than consumer groups. Coppin and High write that their argument is based on what they call "the economic theory of regulation" (a modification of the "capture" theory of regulation), which claims regulation is shaped by competition among officials, and oppose their stance to the "public interest" theory of regulation, or the idea that the government imposed regulation on businesses to protect the public interest. Coppin and High write that they think the "capture" theory is flawed because it "takes as a starting point the view that the Pure Food and Drug Act was originally intended to promote honest business and to protect the consumer." Jack High and Clayton A. Coppin, "Wiley and the Whiskey Industry: Strategic Behavior in the Passage of the Pure Food Act," *The Business History Review* 62, no. 2 (July 1, 1988): 288.

[235] Ilyse D. Barkan, "Industry Invites Regulation: The Passage of the Pure Food and Drug Act of 1906.," *American Journal of Public Health* 75, no. 1 (1985): 18–26; Levenstein, *Revolution at the Table*, 39–40.

[236] Young, *Pure Food*, 41. Young later adds that to these two voices "the panicked appeal of the farmer was soon added" (45).

Recent scholarship on the role of science in the Pure Food Movement has focused on the boundary-work of scientists as they solidified their position as experts in identifying harmful products. These scholars are largely interested in how "technical quantified analysis" took the place of "non-technical cultural values of quality and authenticity in a world of changing connections to nature," as Benjamin Cohen writes in his article on the use of chemistry to define the border between pure and adulterated food.[237] Uwe Spiekermann similarly analyzes the role of the chemical-redefinition of food—or the "nutrient paradigm"—in delineating food standards during this period, claiming it favored producers while alienating consumers. "Science-based nutrition was characterized by ambivalence and uncertainty," Spiekermann argues, "driven by […] the unrealistic belief that nutrients - and not man himself - are decisive for a healthy and rational way of consumption."[238] Using the lens of food regime change and Polanyi's double movement, Amy A. Quark and Rachel Lienesch also examine scientific boundary work in the Pure Food Movement, and, like Spiekermann and Cohen, argue that scientists tended to "mask the values inherent in scientific agendas and construct science as an objective, apolitical domain of knowledge production."[239] These scholars typically recognize that there were disagreements among scientists, but they are less interested in the controversies than in the ways that scientists created boundaries of expertise through "objective" chemical analysis.[240]

In her recent book, E. Melanie Dupuis more starkly presents science as a monolith, acting as a technocratic force in defining food regulations. She writes that in the Pure Food Movement, "most of the Progressive expert-reformers came from Yankee backgrounds. Most were raised in middle-class northeastern religious families with a high moral culture," and therefore mixed professional and moral concerns.[241] This characterization excludes the agricultural chemists in the mid- to far-West who were similarly leading pure food movements in their states. The boundary-work scholarship as well as Dupuis's book show how chemical analysis gained authority in

[237] Benjamin R. Cohen, "Analysis as Border Patrol: Chemists along the Boundary between Pure Food and Real Adulteration," *Endeavour* 35, no. 2–3 (2011): 72.

[238] Uwe Spiekermann, "Redefining Food: The Standardization of Products and Production in Europe and the United States, 1880–1914," *History and Technology* 27, no. 1 (March 1, 2011): 28. He claims that nutrient-oriented standards favored producers, as consumers – who wanted more transparency – were not involved in creating standards. Spiekermann concludes that the nutrient paradigm failed to establish trust in the industrial food system because of this alienation of consumers.

[239] Amy A. Quark and Rachel Lienesch, "Scientific Boundary Work and Food Regime Transitions: The Double Movement and the Science of Food Safety Regulation," *Agriculture and Human Values* 34, no. 3 (September 1, 2017): 648.

[240] Quark and Lienesch, 652. Quark and Lienesch describe the shift from industrial- to public-oriented science, yet they emphasize that "science" as the decider of the healthfulness remained constant. In describing the shift to working for the public sector, they write: "Government chemists felt that, in order to claim the scientific authority to resolve food safety issues for the broader societal good, they needed to be positioned above the class conflict among the food industry, farmers, and consumers" (Quark and Lienesh, 648). Spiekermann also recognizes that "'Science' was not only a changing structure of different disciplines, but it was also bound up in different interests. Food controllers stood against the falsifiers, state officials against the scientists of industrial branches and large firms" (27). The science at the time was contested and ambiguous, he writes, and the "discussion of 'pure food' and food standards highlighted the structural dilemmas and paradoxes of modern knowledge production" (23). Spiekermann claims that the controversies were part of the reason the laws were ineffective in establishing consumer trust until the 1930s, but he generally says there was not controversy in the "basic principles" or nutrient paradigm of the science, and the belief that scientists should establish the standards (21). Spiekermann, "Redefining Food: The Standardization of Products and Production in Europe and the United States, 1880–1914."

[241] E. Melanie DuPuis, *Dangerous Digestion: The Politics of American Dietary Advice*, California Studies in Food and Culture (University of California Press, 2015), 81. Dupuis does not distinguish between scientists and reformers, and, building from Coppin and High's work, focuses on Harvey Wiley to make this claim.

measuring food purity during this era. Rather than looking at debates between scientists, they are interested in how "trust in numbers" replaced other traditions of assessing the healthfulness of food.

Some scholarship points to a debate between scientists by examining the scientific controversies surrounding Harvey Wiley, but this scholarship most often criticizes Wiley for being decidedly *unscientific* in his disagreement with other scientists. Leading this charge are High and Coppin, who argue that Wiley took arbitrary positions and created discriminatory policies in order to protect traditional industries and enlarge his own position. According to Coppin and High, Wiley's preference for "natural" foods and skepticism of "artificial" foods were based on unscientific and "emotional" arguments, particularly because many so-called natural foods were processed.[242] This not only unfairly harmed large food processors, the authors claim, but also hurt urban consumers: "it was hardly in the public interest for urban dwellers to purchase boiled food containing no preservatives or to be denied large categories of items that could not be found fresh within the city."[243] High and Coppin go as far as to say that the entire movement for food regulation originated from elites vying for power rather than from a real threat to public health, claiming that "no substantial issues of health and purity were at stake."[244] Invested solely in his own advancement, Wiley made hypocritical arguments and flip-flopped on issues, the authors claim. They use Wiley's preference for straight whiskey over rectified whiskey to exemplify this point: from a scientific standpoint, Wiley should have argued that rectified whiskey with added flavoring and coloring was purer than straight whiskey made with traditional ingredients and distilled in barrels. High and Coppin argue: "Aged whiskey contained larger amounts of poisonous fusel oil than rectified, and rectified whiskey sometimes had small amounts of coloring and flavoring that were absent from aged whiskey. These differences were minor, and there was no scientific basis in chemistry for Wiley's position."[245]

This chapter challenges this characterization of Wiley and other agricultural chemists as unscientific in their disagreement with pure and industrial chemists. High and Coppin argue that Wiley's prejudice against oleomargarine, rectified whiskey, and alum in baking powder was unscientific because chemically these products had insignificant differences with the traditional products, and these products were later proven to be harmless. High and Coppin not only use present-day knowledge of the safety of these products in this claim, but as economic historians they reveal a narrow view of what should be labelled and regulated, as they fail to consider food values outside of chemistry, such as taste. Alum in baking powder, barrel-aged whiskey, and oleomargarine all have distinct flavors that consumers may have wanted to know about before purchase. Scholars like High and Coppin seem to echo the chemically reductionist arguments made by pure and industrial chemists. More importantly, when Coppin and High argue that

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242 Clayton A. Coppin and Jack C. High, *The Politics of Purity: Harvey Washington Wiley and the Origins of Federal Food Policy* (Ann Arbor: University of Michigan Press, 1999), 32. They argue that Wiley's skepticism based on limited scientific knowledge was unscientific because, they argue, scientific claims cannot be made based on the possibility of new knowledge in the future.
243 Jack High and Clayton A. Coppin, "Wiley and the Whiskey Industry: Strategic Behavior in the Passage of the Pure Food Act," *The Business History Review* 62, no. 2 (July 1, 1988): 290.
244 Coppin and High, *The Politics of Purity*, 34. "The real issues at stake in regulation were market share, corporate profit, and bureaucratic control," they write.
245 High and Clayton A. Coppin, "Wiley and the Whiskey Industry," 300.

"rectified whiskey had fewer impurities in it than straight whiskey," they are using their own definition of purity.[246]

Rather than using present-day knowledge to evaluate scientific claims in the past, this chapter seeks to understand the contemporary context of how scientists assessed food safety and fraud. In a 1968 article on Wiley's research on benzoate of soda, Young argues that scholars have misjudged Wiley by not evaluating his work within its historical context. While Wiley may have been biased and his claims later disproven, Young explains that he introduced important scientific methods for testing food safety.[247] This chapter avoids using current scientific knowledge and understandings of safe and healthful foods to evaluate the pure food debates. It is difficult to label scientists as hypocritical or unscientific based on present-day scientific knowledge or present-day understandings of health and nutrition, as both pure/manufacturing and agricultural chemists made claims that were later disproven by scientists. Instead, this chapter seeks to understand how scientists on both sides of the debate defined pure food, argued for their position, and envisioned the future of the American food system.

Wiley was not alone in his opposition to pure and industrial chemists; he worked with a network of agricultural chemists across the country—especially in the mid and far West—who were organized through the Association of Official Agricultural Chemists. Young, and more recently Cohen, have recognized the important place of these chemists in creating food standards. Young also notes the divide between agricultural chemists in the Association of Official Agricultural Chemists (AOAC)—especially Wiley—and manufacturing chemists and includes the arguments of chemists alongside congressmen and others in his chronological history of congressional debates over pure food. This chapter builds on his work by focusing in on the arguments made by chemists throughout these debates to understand the divide between scientists. Cohen focuses on Wiley as representative of the chemists in the AOAC, and he argues that Atwater and Wiley were ultimately more similar than different in their use of quantitative analysis in measuring food purity.[248]

Both Young and Cohen also recognize the important place of farmers advocating particularly for the regulation of oleomargarine, but this is considered separate from the scientific debate. Young notes of Wiley's disagreement with Atwater on oleomargarine:

> Here Harvey Wiley revealed a fundamental preference for the natural over the artificial that later prompted him to take some stands which, in retrospect, were scientifically wrong. In this instance he was right, anticipating that butter contained some important ingredients, in contrast with the oleomargarine of the day, that his new microscope could not detect and that Atwater did not suspect.[249]

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[246] High and Clayton A. Coppin, 299. At one point, Spiekermann also uses his own definition of purity to accuse past actors of hypocrisy, saying American food producers put "pure" on their labels "even if the consumption of some 'pure' products was not closely linked to a healthy or sustainable diet." While consumers might link purity to health and sustainability today, in the past it was more closely linked to traditional processing and natural ingredients. Spiekermann, "Redefining Food: The Standardization of Products and Production in Europe and the United States, 1880–1914," 26.

[247] Young, "The Science and Morals of Metabolism: Catsup and Benzoate of Soda."

[248] Cohen, *Pure Adulteration*, 215–16.

[249] Though Young writes that here Wiley was right, he notes that Wiley's microscope could not have detected the nutritional difference. Young, *Pure Food*, 104.

Wiley's preference for "the natural" is not noted as scientific. Cohen does not discuss Wiley's preference for "natural" food, and his book generally focuses on the chemists who argued in favor of manufactured foods. He details the agrarian arguments for regulating oleomargarine that connected manufactured foods to a disrupted agricultural landscape, but central to his thesis is that the work of scientists was separate from these agrarian movements. Cohen writes that Wiley's work "characterizes how formerly environmental concepts of purity, dynamic and agricultural, moved into the realm of chemical analysis, static and analytical."[250] Referencing a political cartoon, Cohen writes that "The three headed monster [of glucose, oleomargarine, and cottonseed oil] in the fields of American farms would eventually be subdued not by the spears of agrarian grangers but by the microscopes of analytical chemists."[251] This chapter supports Cohen's argument that chemical analysis moved definitions of food purity "toward products and away from processes," while also suggesting that those agrarian grangers and state analytical chemists were allies in attacking the "monster" of artificial foods. Agricultural chemists were closely connected to farmers and farming processes, and the move of purity from "process to product" may have been an unintentional consequence.

While historians like Young and Cohen have recognized the importance of agrarian regions, and of state agricultural chemists, in leading the fight for pure food laws, few have examined the arguments made by the scientists in these regions. This may be because these scientists do not fit neatly into the main narratives outlined earlier: the agricultural chemists spoke with both a reform and a business voice; their main constituents included both consumers and food producers; and their use of scientific expertise was often populist rather than bourgeois or technocratic. Historians may have also written off the arguments of agricultural chemists as unscientific, romantic, and biased by their farming constituents, and thus not a part of a serious scientific debate.

The exception to this rule is an oft-cited short article written in 1964 by R. James Kane on Edwin Ladd, an agricultural chemist at the North Dakota Agricultural College (now North Dakota State University), leader in the Pure Food Movement, and eventually a U.S. senator. Kane argues that Ladd was instrumental in passing the law by tying the pure food movement to populist movements. Though Kane calls for more work to be done on this subject, as western agricultural states were instrumental in passing the Pure Food and Drug Act, few scholars (if any) have heeded his call.[252] This chapter attempts to answer Kane's call by examining the scientific debate that took place between pure and agricultural chemists over the meaning of "pure food" between 1885 and 1910, with a focus on agricultural chemists whose viewpoint is largely missing from the current historiography.

State agricultural chemists, particularly in the mid to far west, were allied with farmers in the debate over Pure Food, arguing for federal regulation of food labelling not only to protect consumers and producers from fraud, but also, they argued, to protect access to "natural" and "wholesome" foods against the tide of "industrial" and "artificial" foods, as well as to protect farmers who produced "natural" foods from losing power in the industrializing food system.[253] These agricultural chemists emphasized the limits of scientific knowledge and made scientific arguments for what appear to be nonscientific food values, including tradition, nature, and taste.

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[250] Cohen, *Pure Adulteration*, 204.
[251] Cohen, 221.
[252] Kane, "Populism, Progressivism, and Pure Food."
[253] In this chapter, when chemists discuss natural foods, they mean foods that are either not processed or that are minimally or traditionally processed.

Moreover, they took an anti-corporate standpoint in emphasizing the dangers of food production leaving the hands of small producers and farmers, applying a moral economy to market regulation and science. From the perspective of farmers and state agricultural chemists during this period, the Pure Food Movement appears to be more populist and agrarian rather than technocratic and progressive.

I. The Rise of Manufactured Food and Its Scientific Supporters

While food adulteration took place long before the late nineteenth century, changes in the food system during this era challenged previous methods of regulation. New processing techniques, preservatives, and refrigeration allowed for a greater distance between food producers and consumers and meanwhile disrupted local systems of food control. In a public meeting on food adulteration in 1881, Yale chemist Samuel Johnson, who worked with Wilbur Atwater at the Connecticut experiment station, described how the trust between producer and consumer in a localized food system protected against fraud. Johnson explained that while milk adulteration was common in Boston and New York, it proved rarer "in New Haven, where producers and consumers meet face to face [… and] the temptation to water is not so urgent." Johnson found that all samples of milk from New Haven were pure.[254] The first popular USDA bulletin on food adulteration, published in 1890, depicted a similar phenomenon in meat production: when "the butcher was known by the consumer; he had a reputation to maintain, and he was subject to local laws and sanitary regulations**.** At present the identity of the butcher is lost in a distant packing center."[255] The meat packing plant was both anonymous and outside of the reach of local inspection. Commentators argued this had allowed fraud to become commonplace, since the food producers could now adulterate their products and "look into their neighbor's countenances without a downcast eye and a shamed face," as Congressman Brosius of Pennsylvania stated at the Pure Food Congress in 1898.[256] This anonymity was not just about distance—industrial food items were products of various, disparate producers and manufacturers.[257] Anonymity and distance broke personal connections that established trust, obviated the need to maintain an honest reputation, and challenged enforcement of local laws.

At the same time, new developments in food processing hindered the ability of consumers to protect themselves against food adulteration by using their senses of sight, smell, and taste. "The rapid advance of chemical science has opened a wide doorway for compounding mixtures so nearly resembling nature's products that the senses are impotent to detect the difference," reported

[254] Samuel W. Johnson, "Adulterations in Food," *Journal of Social Science, Containing the Transactions of the American Association*, Saratoga Papers of 1880, 13 (March 1881): 121. Johnson noted this in a call for chemists, who had previously helped farmers by analyzing fertilizers, to analyze foods. Wiley would repeat this in 1886. In this paper, Johnson also noted a potential geographical divide in adulteration. Of watering milk, he stated that "what is true in New Haven does not necessary apply to other cities South and West" (121).
[255] Alexander John Wedderburn, *A Popular Treatise of the Extent and Character of Food Adulterations*, United States Division of Chemistry Bulletin 25 (Washington DC: Government Printing Office, 1890), 30.
[256] *Journal of Proceedings of the National Pure Food and Drug Congress Held in Columbian University Hall, Washington, D.C., March 2,3,4, and 5, 1898* (Washington DC, 1898), 8. See also: Young, *Pure Food*, 126.
[257] Benjamin Cohen notes that the new need for regulation was "about thickness, opacity, and confusing sightlines as much as distance." Cohen compares the act of purchasing butter from a creamery to margarine, which was "a product of stockyards, slaughterhouses, animal fat processors, chemists, oil traders, mechanical pressers and heaters and boilers, coloring matter (usually new chemical derivatives), and other ingredients." Cohen, *Pure Adulteration*, 10.

a committee on food adulteration in 1879.[258] Items previously preserved with salt, sugar, smoke, and vinegar were now preserved with tasteless and scentless chemicals. Some articles, like oleomargarine and glucose, were dyed and processed to directly imitate products like butter, maple syrup, and honey. Cans might contain spoiled and discolored fruits and vegetables, hidden from the discerning eye of the purchaser. "The four senses which God has given us are completely baffled," said Congressman Beach of New York in a hearing on oleomargarine in 1886, "nor did the family dining table come equipped with either microscope or reagents for chemical analysis."[259] As chemists had created products that eluded the nose, eyes, and palate of the consumer, chemists now also seemed to offer the only means of protection against fraud.[260]

Chemists thus had a new elevated role in the debates over food regulation, but from the onset of these debates, they were divided on how exactly to define injurious food and create a healthful food system. This divide emerged with the first federal food regulation in the United States—the Oleomargarine Act of 1887. Invented by a chemist in France in 1869 to imitate butter amid rationing during the Franco-Prussian War, oleomargarine was manufactured through a laboratory process that converted tallow into a white spread, which was dyed yellow to look like butter. In the late nineteenth century, with the rise of factory-sized slaughterhouses in Chicago, meatpackers eagerly picked up the new use for their waste products.[261] Soon after, manufacturers began to create oleomargarine from new substances, including cottonseed oil, vegetable oil, and coconut oil, and sometimes mixing their imitation with real butter.

Oleomargarine directly competed with butter and held the potential for fraud, as grocers, boarding houses, restaurants, or hotels could sell or serve oleomargarine as butter to unknowing consumers.[262] In response, several states, particularly ones with powerful dairying interests like Wisconsin, passed strict laws regulating the use and sale of oleomargarine.[263] These included taxing the substance, requiring restaurants, hotels, and boarding houses to notify customers when it was served, and requiring the food to be dyed pink so that consumers would not eat it under false pretenses. The federal Oleomargarine Act was passed with the stated purpose of protecting consumers and honest dairymen from the harm of a counterfeit product, but many wondered whether the government was unfairly aiding the dairymen of the country. After signing the act, President Cleveland questioned if the "real purpose [of the act] is to destroy, by the use of the taxing power, one industry of our people for the protection and benefit of another."[264] While commentators disagreed on whether the government should regulate imitation products simply because of the potential for fraud, most agreed that if a food was proven harmful to public health,

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[258] Beach may have cited four senses instead of five because sound was not frequently used in assessing food quality, so he instead referred to sight, smell, touch, and taste. Of course, sound can be used to assess food quality (such as knocking on a crusty loaf of bread), but I have not seen sound referenced in discussions of adulteration during this period. Quoted in Young, *Pure Food*, 59.

[259] Quoted in Young, 86.

[260] Rather than adding "fingers" to the list, I use palate to include both taste and texture here. Benjamin Cohen notes that chemists were both "cause of and solution to adulteration" as well. Cohen, *Pure Adulteration*, 180.

[261] The center of oleomargarine manufacturing in the United States actually began in New York City, but quickly moved to Chicago with its rising meat industry. At the same time, butter production also shifted westward, from the Northeast to the upper Midwest. Cohen, 80. See also Cohen's digital companion site for interactive maps on the geography of these industries: https://purefood.lafayette.edu/

[262] This was a time when butter was sold in bulk, not in packages, so it was easier for a grocer to commit fraud.

[263] The first legislation against oleomargarine passed in New York in the 1877. For a visualization of how state laws regulating oleomargarine developed over the 1870s and 1890s, see Benjamin Cohen's companion website to his book: https://purefood.lafayette.edu/maps/margarine-legislation/

[264] August 1886, Message from President Grover Cleveland on Oleomargarine Act, 2.

the government was obligated to pass regulations. Scientists in the pure food debates thus focused on proving the relative harmfulness or healthfulness of artificial foods.

On one side of the debate stood the "pure" scientists, who often worked in laboratories in the Northeast, and scientists funded by industry. This group of chemists were defined by their scientific certainty and scientific reductionism, as their main argument in favor of artificial foods was based solely on the foods' chemical properties. During this period, scientists studying nutrition worked within the "calorimetric paradigm," which held that all food was composed of the same components—fat, protein, carbohydrates, and minerals. By this logic, chemists could synthetically extract and mix these components to recreate foods, resulting in artificial products such as oleomargarine and glucose syrups. Through the lens of chemistry, artificial foods were identical to natural foods, and thus, pure chemists argued, equally wholesome and affordable substitutes. As the Yale chemist Samuel Johnson wrote: "When skillfully made [glucose syrups] are perfectly palatable and equally nutritious and healthful [as cane syrups]. Glucose, like oleomargarine, is a perfectly legitimate object of production and an entirely wholesome article of food."[265] In congressional hearings on pure food throughout this era, witnesses often cited long lists of chemists who equally argued that oleomargarine, glucose, and other artificial items were "perfectly good and wholesome articles."[266] According to these chemists, artificial foods were a valuable addition to the food supply, as they delivered chemically identical and affordable alternatives to natural foods.

Professor Charles Chandler of Columbia College, a chemist who had been hired by a number of food manufacturers to make analyses, most vocally defended oleomargarine from this perspective in the 1886 hearings.[267] "I have taken the ground that this is a new process for making an old article, and that article is butter," Chandler claimed, adding that the laboratory was in fact superior to the dairy farm: "the processes by which this kind of butter is manufactured are much more cleanly then the processes by which dairy butter is manufactured."[268] Chandler challenged the divide between natural and artificial foods, pointing out that "butter is a manufactured article just as oleomargarine is a manufactured article." Oleomargarine was colored yellow, according to Chandler, "because it is butter, just as the other is butter" –prompting the committee to request that he use the terms "artificial butter" and "dairy butter" to distinguish the substances. Later in the hearing, he explained that when he used the same term for both substances, he "spoke scientifically." "There is nothing in one not found in the other," he asserted. "All the percentages of stearine, palmatin, and olein and the percentages of water and of salt, are practically the same in the two kinds of butter."[269] Taking scientific reductionism to the extreme, Chandler claimed that because oleomargarine was chemically identical to butter, it was butter.

According to the pure chemists, only prejudice stood in the way of the adoption of these new artificial foods. Henry Morton, a professor of chemistry and physics at the Stevens Institute

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[265] Johnson, "Adulterations in Food," 109.

[266] Professor W.R. Nichols of Boston, quoted in: "Debate on Adulteration," *Journal of Social Science, Containing the Transactions of the American Association*, Saratoga Papers of 1880, 13 (March 1881): 134.

[267] Young, *Pure Food*, 63–65, 69, 72. Young notes that contemporaries thought Chandler's position was compromised due to his work with manufacturers, and that Chandler "privately confessed his belief that the laws was intended to more to reassure the public than to clamp down stringently on manufacturers" (64). Benjamin Cohen also discusses the work of Charles Chandler, and argues that his view represented that of most scientists during this era. He does not discuss Chandler's connections with industry. See: Cohen, *Pure Adulteration*, 17, 98–100.

[268] U.S. Congress, Senate, Committee on Agriculture and Forestry, *Testimony in Regard to the Manufacture and Sale of Imitation Dairy Products,* 49th Cong., 1st sess., Senate Misc. Doc. 131 (1886), 67.

[269] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 78-79.

of Technology in New Jersey, explained during the hearings: "our tastes depend very much on habit, and if we had been brought up to eat marrow instead of butter…then it would be undoubtedly desirable…for the appetite seeks what it is accustomed to in these things rather than a new thing for which a taste is to be acquired."[270] As butter and oleomargarine were supposedly chemically identical, and many consumers could not taste the difference between the two (according to these chemists), these chemists claimed that a dislike of oleomargarine demonstrated an unscientific prejudice against artificial food. Chandler described tricking his family into eating oleomargarine, which they ate "for two days without discovering what it was." However, when he switched it for a butter that they suspected was oleomargarine, "nothing would induce them to touch it." Chandler, however, rose above this unscientific prejudice. Whether butter or oleomargarine, he declared, it "makes no difference to me. I like oleomargarine, and am perfectly satisfied with it."[271] Another chemist, when asked whether he would eat pink oleomargarine, stated: "I suppose a chemist will do very many things that the general public will not do. The public are always very slow in such matters, and it will take a good many years for people to overcome the prejudices related to oleomargarine."[272] Through their understanding of chemistry, these men claimed a superior understanding of food above the biases of taste and custom. Professor William Ripley Nichols of MIT specifically noted that this unscientific prejudice may hurt the poor. "Perfectly good and wholesome articles of food, like glucose and oleomargarine, substances which ought to be considered valuable additions to the food supply of the poor," he stated, "are branded as poisons, and an utterly unwarranted prejudice is created against them."[273]

Calls for regulation or restriction of artificial foods were thus framed as backwards and anti-science, as well as potentially harmful to the material progress of the poorer classes. "Can Congress prohibit men of science from making new discoveries?" asked Congressman William Kelley of Pennsylvania in a hearing on oleomargarine. "Can it prohibit ingenuity from making new inventions? Can it deliberately assume as a duty resistance to mental and material progress?"[274] In a hearing on food adulteration in 1900, a manufacturer insisted that butterine "is a product of the advanced age. Science has effected this."[275] Oleomargarine represented the application of science to a societal issue, and attempts to regulate oleomargarine were thus attempts to slow scientific and social progress. "If now every time that science makes an improvement in our condition, or adds anything to the common comforts and support and civilization of mankind," prodded Senator Vance of North Carolina in the 1886 hearings, "the industry which is supplanted by that improvement has to be supported and carried along by public taxation," society would never progress. "Had we not better abandon all attempts to promote science and be done with it?" he asked.[276]

The chemists who argued against artificial foods, the pure chemists claimed, were simply minions of the dairying and farming industry. In his 1887 *Century* article, Atwater explained that

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[270] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 52.
[271] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 78.
[272] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 95 (statement of James F. Babcock of Boston.)
[273] "Debate on Adulteration," 134–35.
[274] William D. Kelley, speaking on May 25, 1886, 49th Cong., 1st sess., *Congressional Record*, 4898. See also: Young, *Pure Food*, 81.
[275] US Congress, Senate, Committee on Manufactures, *Adulteration of Food Products*, 56th Cong., 1st sess., 1900, 316 (statement of Henry C. Pirrung). People used the terms "oleomargarine," "artificial butter," and "butterine" interchangeably in the late nineteenth and early twentieth centuries. Cohen, *Pure Adulteration*, 75.
[276] Quoted in Young, *Pure Food*, 81.

the "representatives of the dairy interest" had created a "popular prejudice" against imitation butter. "Every reasonable measure to prevent fraud, here as elsewhere, ought to be welcomed," he conceded, but it was unjust to regulate oleomargarine simply because "the profits which a class, the producers of butter, have enjoyed from the manufacture of a costlier article may be diminished."[277] He attacked the tax on oleomargarine as simply a tax on the poor to protect the dairying interests. "Artificial butter is… a very important food product, despite the unjust and hostile legislation of a number of dairy states," he wrote in a letter in 1895.[278] Chandler compared the forces against oleomargarine to other movements that sought to regulate new industries – from indigo dyes to the use of coal in England – for the sole purpose of protecting established industries.[279] Chandler claimed that he had never found "in this country or abroad, any chemist or physiologist who has any standing in the profession who has ever uttered an opinion adverse to artificial butter. Certain persons who have no standing whatever, in the employ of these parties, who are paid by State governments to hound this article of food, have put forth statements" to create prejudice.[280]

Though the pure chemists wrote off the state agricultural chemists as backwards, unscientific pawns of dairymen, the agricultural chemists could similarly write off many of the pure chemists as the pawns of industry. All chemists who testified were paid in some way for their analyses, so no chemist was free from the possibility of influence from their stakeholders. One congressman pointed out as much in asking Chandler, in response to his accusation that the state and dairying interests had influenced agricultural chemists: "are not the gentlemen who are advocating oleomargarine paid in some way, or do they do it for the public good?…do they do this as a labor of love, in the interest of the public?" Chandler affirmed that yes, "The scientific gentlemen are paid on both sides."[281] Chandler himself had been paid by oleomargarine, glucose, and alum baking powder manufacturers to make analyses. Throughout the hearings, people alluded to the way funding shaped scientific opinions, or, as one witness put it, the way that "chemists and microscopists can disagree in proportion to their fees."[282] The ties to stakeholders and public or private funding influenced scientists on both sides of the debate, and thus these ties are not sufficient reason to discredit one side or another.

II. Farmers and State Agricultural Chemists

As Chandler specified, the chemists arguing against artificial foods were those "paid by the State governments"—agricultural chemists working at land-grant colleges and experiment stations largely in the mid to far West. While Chandler asserted that their ties to agricultural colleges and state governments skewed their scientific arguments, agricultural chemists often framed their work as less biased because, as publicly funded scientists, they worked for "the people." Because consumers could no longer use their basic senses to detect fraud and were encountering new food products with extravagant claims, agricultural chemists sought to use the laboratory to protect the public from deception. In 1901, University of California agricultural chemist Myer Jaffa, for example, cited "sensational advertising" as a reason that nutrition research was needed. "There is considerable misunderstanding about the nutritive value of these foods and

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[277] Atwater, "The Chemistry of Foods and Nutrition. I."
[278] Wilbur Atwater to D.C. Gilman, September 10, 1895. Wilbur Atwater Papers, Cornell.
[279] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 69.
[280] Ibid., 78.
[281] Ibid., 80.
[282] Ibid., 269.

also much sensational advertising concerning them," he wrote; "therefore, I am of the opinion that digestion experiments along this line are urgently called for."[283] Agricultural chemists were particularly tied to serving the interests of farmers. According to Young, farmers supported the creation of the state agricultural experiment stations amidst cases of fraud in chemical fertilizers, a type of fraud that a farmer could not detect until after a failed harvest. In addition to fertilizers, "state chemists employed their analytical skills at exposing other products in which chemistry had been employed to cheat farmers: barn paints, veterinary drugs, feedstuffs."[284] When Harvey Wiley exposed fraud in chemical fertilizers while working at Purdue University, or Myer Jaffa exposed fraud in poultry feeds, or Edwin Ladd of North Dakota exposed fraud in paints, these chemists won the trust and support of their state's majority farming population, who increasingly identified them as champions of the people.[285]

Pure food advocates positioned the state agricultural scientists as counterbalancing the ability of increasingly powerful food corporations to hire scientists both to create and to authoritatively support their new food products.[286] Food manufacturing became a formidable political and financial force during this period. One need only think of the beef trust in Chicago, the breakfast cereal empires of Kellogg and Post, or major companies like Coca-Cola or Heinz that emerged during this period.[287] Manufacturers of cheap alternative or imitation foods and ingredients—like oleomargarine, glucose (a sweetener), and cottonseed oil—which often used byproducts of factory production, also rose in prominence during this time.[288] In an autobiography, an early pure food crusader described the power of glucose and oleomargarine to "retain chemists and health officers and some portions of the public press," and argued that the only congressmen who were vocal in supporting pure food did not fear "the political influence of either glucose or oleomargarine."[289] Later scholars have provided evidence in support of this observation. Sociologist Jeffrey Haydu observes, "Chemists employed by food companies dismissed warnings about preservatives and artificial ingredients, but state and federal chemists offered laboratory results to back up those warnings."[290] State governments needed scientific analysis to detect scientifically-produced fraud and enforce regulations. In 1890, Senator Paddock stated in a congressional report: "Science has been called upon in the interest of honesty to trace and detect the frauds of scientific dishonesty, and the microscope, test tube, retort, and chemical reagent have opened to view the grave and growing consequences of a greed for gain which is assailing the public health, affecting the pocket of the consumer, and undermining […] 'Faith in commercial

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[283] Myer Jaffa to Eugene Hilgard, May 4, 1901, Myer Jaffa Papers, Bancroft Library.
[284] Young, *Pure Food*, 122.
[285] Young, 101. Myer E. Jaffa, *Poultry Feeding and Proprietary Foods*, Bulletin 164 (Berkeley, CA: Agricultural Experiment Station, 1905). "Poultry Man to be an Attraction," *Merced County Sun*, Volume XXXX, Number 15, April 28, 1911, pg. 2. "The Consumer's Champion," *The Weekly Spectrum,* North Dakota State University, January 21, 1908.
[286] This tension with commercial chemists was a part of the founding of the Association of Official Agricultural Chemists (AOAC) in 1884. With Wiley's leadership and prompted by the need for fertilizer standards, state agricultural chemists created AOAC after disputing the standards with commercial chemists, and Young notes that they "welcom[ed] commercial chemists to their discussions but den[ied] them a vote on establishing methods of analyzing fertilizers." Young, *Pure Food*, 123.
[287] Levenstein, *Revolution at the Table*, 30–43.
[288] Cohen traces the rise of these three industries in: Cohen, *Pure Adulteration*.
[289] Young, *Pure Food*, 58, 59.
[290] Jeffrey Haydu, "Frame Brokerage in the Pure Food Movement, 1879–1906," *Social Movement Studies* 11, no. 1 (December 12, 2011): 107.

integrity.'"[291] Without the state chemists, the public would be at the mercy of the science of corporations.

In their depiction of an alliance with farmers against a conspiracy of food corporations, these arguments mirrored the rhetoric of populism that was particularly prevalent in the Midwest during this period. In some ways, the pure-food movement was similar to populist calls to regulate the "middle-men"—particularly railroads and banks—whose owners, according to populist farmers, were unfairly profiting from their labor during a time of agricultural depression and uncertainty. In his popular bulletin on food adulteration in 1890, Wedderburn wrote that there was growing support for food regulation among groups associated with populism, such as Farmers' Alliances and the State Granges. "The demand for this legislation is wide-spread among the farmers of the whole country," he wrote.

> It is confined to no section and is as emphatic as it is universal. Letters, bulletins, and resolutions from the Grange, Patrons of Husbandry, Alliances, and other agricultural organizations demanding legislation have flooded the committee and the House. That the same interest in the subject is apparent on the part of consumers is manifest by the letters, petitions, and memorial of the various labor organizations, appealing for such action as will give them honest food as against the dishonest compounds that not only rob them of their money, but of their health also.[292]

Wedderburn notes an alliance between farmers and laborers in calling for reform that was characteristic of early populism. Yet, the role of populism in the pure food movement also should not be overstated. Historian R. James Kane has noted that none of the congressmen who led the movement for food regulation were a part of the populist party, and "none of the great Populist documents make mention of the need for food regulation."[293] Even so, the agrarian arguments for pure food were clearly influenced by populism. "The fact remains," Kane writes, "that the impulse toward pure-food legislation was in strict accord with the Populist theory that governmental agencies should be made available for redressing of grievances springing out of economic injustice."[294]

At times, this juxtaposition of corporate versus public science in the pure food movement mapped onto a sectional divide between East and West. In 1881, a western newspaper suggested a suspicion of a conspiracy of eastern experts. "Out West it looks as if unscrupulous and dangerous adulterations have poisoned the people and trade until the demand for reform cannot be stopped," the newspaper read, "and 'the wise men from the East' kindly propose to capture and take charge of the whole reform business." The newspaper then mockingly listed the proposals of the eastern experts:

> 1st, There is no danger.
> 2d, Stop the 'ignorant alarmists:' they will damage the business interests of adulterators.
> 3d, Poisoned food eaten three times a day is not as bad as adulterated drugs.

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291 Quoted in Young, *Pure Food*, 113.
292 Wedderburn, *A Popular Treatise of the Extent and Character of Food Adulterations*, 46.
293 Kane, "Populism, Progressivism, and Pure Food," 165.
294 Kane, 166.

4th, The laws we propose, if passed, will not be worth a cent. It is better to do too little than too much.
5th, Don't try to get uniform State laws for you can't.
6th, We don't think, etc., etc.
7th, Don't define what adulteration is (somebody might be caught. If any one [sic] is caught, give the board discretion to let him out.)
8th, Don't hurt any one [sic] much, and under no circumstances pay any one for enforcing the law.
9th, It is desirable that something should be done. [295]

The newspaper claimed that the "wise men of the East" were downplaying the harms of adulteration and attempting to hinder the creation of laws that clearly defined adulteration, enforcement, and penalties. The eastern authorities, the newspaper argued, wanted to make the law a dead letter, while creating an illusion that the food supply was safe. One pure food reformer highlighted that though some "chemists and writers den[ied]" his assertions of the danger of food adulteration, his claims had been proven "not only by Eastern authorities, but also by *the overwhelming evidence of the chemists, microscopists, and health-officers of the West, particularly at Chicago, and that again by the judges of the courts and prominent* citizens in regard to their scientific standing" (his emphasis).[296] These pure food advocates tied eastern chemists to manufacturing interests, and western chemists to farmers and consumers.

Western commentators, politicians, and scientists at times portrayed the pure food movement as a regional divide between the manufacturing east and the agrarian west. Perhaps nobody was more animated in this argument in the congressional hearings than Congressman Henderson of Iowa. He chastised congressmen who would "defend a few glutted money corporations and capitalists and strike down the purest industry that gives safety and business prosperity to the nation —the great farming industry… if the farmers of this land and the great, glorious West are to be sacrificed to protect your iron industry, you will get your 'eye-teeth' out before many Congresses come and go."[297] Other western congressman took up this framing of pure food as a sectional issue. "Indeed," writes Young in his history of the movement, "in the twentieth-century climax of the effort to secure a pure-food law, almost all the congressional leaders in that struggle came from agricultural states west of the Mississippi River."[298] In these states, the pure food movement was as much about the interests of farmers as it was about consumers. "The Western country demands and will have protection," Henderson declared, "by argument if need be, by war if necessary." [299]

While outright war was avoided, battles took place in the state agricultural laboratories, as agricultural chemists exposed fraud and faced the threats of food manufacturers. Edwin Ladd embodied this image of the battling chemist. From his arrival at the North Dakota Experiment Station in 1891 –when he began work on a grain grading system that would thwart "unscrupulous purchases" and "dishonest buyers"—Ladd sought to use the laboratory to protect farmers from

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[295] Excerpted in George T. Angell, *Autobiographical Sketches and Personal Recollections* (Boston: Franklin Press: Rand, Avery, & Co., 1884), 26.
[296] Angell, 68.
[297] David Henderson (IA), speaking on July 9, 1888, 50th Cong., 1st sess., *Congressional Record,* 6023.
[298] Young, *Pure Food*, 182.
[299] Quoted in Young, 88.

being cheated by the industrializing food system.[300] Between 1901 and 1905, Ladd helped to draft and pass state laws that strictly regulated food and other products. The 1903 law prohibited the sale of "any article of food or beverage which is unwholesome or adulterated," which was defined broadly to include substances that contained coal tar or aniline dye, products mixed with ingredients that "lower or injuriously affect [the product's] quality or strength" or from which any "necessary or valuable constituent has been removed." It prohibited the sale of foods branded "so as to mislead the consumer," and it prohibited the sale of any food that contained new chemical preservatives including "formaldehyde, benzoic acid, sulphites, sulphurous acid, or salicylic acid."[301] Though many food manufacturers protested, claiming that these chemicals were safe and necessary for manufacturing their products, Ladd insisted that the law was neither "unnatural" nor a "hardship on honest manufacturers." "In fact the manufacturers of high grade pure goods have not complained," Ladd continued, "but the man who produces inferior products made to appear as high grade by use of chemicals, or the man who poses as a friend of pure foods, but whose goods are not what the public suppose them to be, is the man who has opposed the law."[302] Only dishonest and greedy individuals, Ladd proclaimed, opposed the pure food laws.

In 1902, as the State Food Commissioner, Ladd began publishing bulletins that explicitly listed the manufacturers whose products directly violated the North Dakota food laws. Soon after publishing, Ladd was sued by an eastern association of manufacturers. "The expected has happened," reported the *Fargo Forum and Daily Republican*. "Professor Ladd entered upon the duties of his office fearlessly, honestly, but considerately," as he gave manufacturers "ample warning" to comply with the law. Yet, he now faced a damage suit of $100,000 that "is in reality for the purpose of defeating a most righteous law. The parties suing Professor Ladd desire to sell food products in North Dakota that have been demonstrated by chemical analysis to be detrimental

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300 Ladd's first goal was to create an equitable grain grading system, for "the protection of the producer against unscrupulous purchases, and of the honest dealer against the unfavorable influence of dishonest buyers." *First Annual Report of the North Dakota Agricultural Experiment Station* (Fargo, ND: The Daily Republican Print, 1891), 16. In 1915, he described how wheat grading had been unfairly cheating farmers, as millers would classify wheat as low-grade when purchasing it from farmers, but then sell it as high-grade flour. He found that grain was frequently bought at one rate and then sold to a terminal elevator at another rate. After he was elected to the U.S. Senate in 1921, Ladd devoted part of his first speech in congress to this issue: "The flagrant injustice of allowing the grades of grain to be arbitrarily fixed by the buyer is best evidenced by the fact that the great terminal elevators at Minneapolis and Duluth habitually sold more bushels of high-grade grain than their records showed they had purchased from the farmers. Evidently by some mysterious hocus-pocus grain became enhanced in value after it had left the farm and gone into the hands of the grain buyers, and, of course, this manipulation in grades cost the farmers of North Dakota in the aggregate many millions of dollars every year." He also described how the climate of 1916 had resulted in shriveled kernels of wheat that the grain buyers said was not fit for human consumption, and so they purchased the entire crop as feed. "It was afterwards discovered that the mills of Minneapolis not only manufactured this wheat into flour but had the supreme audacity to claim superior quality for this flour on the ground that it was unusually rich in gluten—absorbed a large amount of water and made an exceptionally large loaf of nutritious bread." Senator Edwin Ladd, "The Nonpartisan League, Its Origin, Development, and Achievements," on May 2, 1921, 67th Cong., 1st sess., *Congressional Record*, 918.

301 In his "hints" for complying with the law, Ladd noted the specific products that might be at risk for adulteration, including cider vinegar, coffee, honey, maple syrup, and tomato catsup. He wrote that the law prohibited the use of saccharin beginning in 1904. He also wrote that the words "artificial," "compounded," and "imitation" needed to be printed in the same size and font as the word they were modifying on labels. *Fourteenth Annual Report of the North Dakota Agricultural Experiment Station* (Bismarck, ND: Tribune, State Printers and Binders, 1904), 221–28.

302 Edwin F. Ladd, *Adulteration Food Products and Food Studies*, Bulletin 63 (Fargo, ND: North Dakota Agricultural College, Government Agricultural Experiment Station, 1904), 462.

to health and are not what they purport to be, and therefore fraudulent."[303] Ladd's use of "chemical analysis," the article emphasized, exposed the conspiracy of manufacturers in violating North Dakota's laws. This suit was never brought to trial, but Ladd continued to face libel suits with each published bulletin. He later described being sued by the eastern manufacturers' association, the whiskey ring, the meat packers, and the "big milling interests who would have us eat their bleached flour, made, at times, from damaged wheat…do you know for more than two years I did not go to bed a single night without a libel suit or injunction, or both, hanging over my head, and knowing on the morrow I must be preparing for my defense?"[304]

With each lawsuit, Ladd increasing appeared as a "North Dakota's Champion," as one headline read.[305] The lawsuits further enforced the image of state chemists allying with consumers and honest farmers against corrupt corporations. "His rigid enforcement of the law has made its provisions vital, and made him the target of 'Big Business' for years," a newspaper later reported. "He is a man of rugged honesty and rare tenacity of purpose. He is the friend and benefactor of every farmer in North Dakota and has proven it in times without number in open warfare against dishonest manufacturers."[306] Ladd's election to the U.S. Senate in 1915, largely on the platform of enforcing pure food laws and using laboratory analysis to protect farmers and consumers from "dishonest manufacturers," demonstrates that this sentiment was widely held by North Dakotans. It also demonstrates an alliance between agricultural chemistry and agrarian politics.[307] "He is considered a strong man of the West if not of the country in his calling," one newspaper declared, specifically connecting the Pure Food Movement to the West, "and if he is to be beaten in his great climacteric undertaking it will be because the [manufacturers] have better 'cards,' better support or a better contention for their sides of the case, and Commissioner Ladd, who is an expert, thinks they have not."[308]

The East-West divide was not strictly geographical, and is perhaps better understood as an agrarian-manufacturing divide, where most chemists associated with farmers lived in the West and most pure and industrial chemists lived in the East. Libel cases at the Maine Experiment Station challenge the idea of a purely sectional divide. In 1904, the Maine station exposed the false claims of advertisements for new breakfast cereals and coffee substitutes. "The Director of the Station was at once threatened with prosecution by a certain firm manufacturing one of the prominent foods," Jaffa described in an article on the Pure Food Law in 1904. "A reply was made to the

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[303] "Attack on Commissioner Ladd was not Unexpected," *The Fargo Forum and Daily Republican,* September 16, 1904, "Biographical Papers - H.L. Walster," Edwin F. Ladd Family Papers, Institute for Regional Studies, North Dakota State University (Hereafter, Ladd Family Papers). The *Fargo Forum and Daily Republican* also reported on another libel suit against Ladd on September 14, 1904, specifying that he was being sued by "an eastern manufacturer's association." "Those who are familiar with pure food affairs are inclined to believe that this suit is the first step in an attempt to overthrow or make ineffective the pure food law." Ladd Family Papers.

[304] Edwin Ladd, "What the Department of Chemistry has done for the North Dakota Farmer," The North Dakota Farmer 14 (8): 3, February 15, 1913. Quoted in "Biographical Papers - H.L. Walster," Ladd Family Papers..

[305] "North Dakota's Champion," *The Dickey Reporter,* Lamoure County, North Dakota, January 10, 1908. Microfilm, State Historical Society of North Dakota, Bismarck, North Dakota.

[306] "New Farm School Head Foe of 'Big Business,'" *Walsh County Record*, Grafton, North Dakota, March 8, 1916. Ladd Family Papers.

[307] Ladd ran for U.S. Senator as a candidate of the Non-Partisan League, a political party that arose from farmer discontent in North Dakota. In his history of the Non-Partisan League, historian Michael J. Lansing describes the way milling contributed to this discontent. He writes that local banks "gouged farmers with exorbitant interest rates on mortgages. Minneapolis-based milling companies controlled commodity prices and railroad shipping rates. They also exerted undue political influence in Bismarck" (ix). Lansing notes that Ladd was the first Non-Partisan League politician to reach the US Senate. Lansing, *Insurgent Democracy*.

[308] "North Dakota's Champion," *The Dickey Reporter,* Lamoure County, North Dakota, January 10, 1908.

effect that the Director was very desirous of such a suit being brought, because he could then give more publicity to the results of his work than he had been able to do in the station bulletin. No answer was returned to that letter."[309] The station specifically attacked the claims of Grape-Nuts – a product of Charles Post's large manufacturing company based in Michigan – and used laboratory analysis to make plain the falsity of their statements. While Grape-Nuts advertisements claimed that "one pound of Grape-Nuts provides more nourishment than ten pounds of meat, wheat, oats, or bread," for example, the experiment station provided a table comparing the nutrients in one pound of Grape-Nuts to ten pounds of the other items, clearly demonstrating that the advertisement was untrue (Figure 10). The use of chemistry made plain the absurdity of the cereal advertisement. Once again, the libel suits demonstrated a pattern of state chemists working to protect consumers from large corporations.

104 MAINE AGRICULTURAL EXPERIMENT STATION.

POUNDS OF PROTEIN AND FUEL VALUE OF ONE POUND OF GRAPE NUTS COMPARED WITH 10 POUNDS OF BEEF, ROLLED WHEAT, WHEAT FLOUR, ROLLED OATS AND BREAD.

	Protein —lbs.	Fuel value – calories.
1 pound of Grape Nuts....................	.12	1,870
10 pounds round steak, including bone.......	1.90	8,950
10 pounds beef rump, including bone........	1.29	14,050
10 pounds rolled wheat....................	1.01	17,650
10 pounds bread flour.....................	1.31	16,450
10 pounds rolled oats......................	1.50	19,650
10 pounds white bread....................	.80	12,200

While there is no question that Grape Nuts is a good cereal food, it is difficult to understand why the manufacturers should make claims so absurd and contrary to fact.

Figure 10: "Cereal Breakfast Foods," Bulletin No. 55, Maine Agricultural Experiment Station (Orono, Maine), November 1899: 104.

As some eastern agricultural scientists exposed fraudulent advertising, there were also midwestern scientists who worked for food manufacturers, and whose congressional testimonies

[309] Jaffa, "Pure Food Law," California State Journal of Medicine, Vol. II, No. 6, June, 1904, 181. The director of the Maine Station during this time (from 1896-1920) was Charles D. Woods, who also worked with Atwater on a number of dietary investigations. Again, this shows that the line between the agricultural tradition, and the pure tradition, of nutrition science is somewhat fluid, particularly as chemists moved institutions.

downplayed the danger of "artificial" foods and preservatives and argued against federal regulation. Two scientists in particular challenge the idea of an East-West divide – Vincent Vaughan, a physiological chemist and dean of the medical school at the Michigan Agricultural College, and Edward Kremers, head of the University of Wisconsin School of Pharmacy. Both of these chemists were hired by a food manufacturer to conduct examinations on chemical preservatives before testifying before congress, and though they both worked for agricultural colleges, neither of them, notably, were agricultural chemists.[310] Vaughan, in fact, directly attacked the idea that the agricultural chemists of the AOAC should be charged with creating standards. "Men who are engaged all their lives in assaying soils and estimating the value of fertilizers are not fitted by education to determine the effect of anything on the human body," he proclaimed.[311] The East-West divide is thus not a strict boundary – it might be better understood as chemists aligned with manufacturing interests on one side, and those aligned with farmers on the other.

Wariness of the growing power of corporations and their influence on government—a theme that stirred the broader populist movement—consistently appeared in arguments for pure food among westerners and agriculturists. In the 1886 debates over margarine, James Harvey Young has described how "friends of the dairymen invoked an agrarian myth" that described farming as "the very father and mother of all industries," as one speaker put it.[312] In the oleomargarine debates, speakers often accused the government of protecting a few wealthy capitalists to the detriment of millions of farmers. "This is a fight between 7,500,000 agriculturists and a score and a half of capitalists and manufacturers who would see the world sink if they could get a golden canoe to float to heaven in," declared an Iowa farmer on the floor of Congress. "While these persons are growing rich through fraud and deception, we are told the farmers and dairymen have no case."[313] Multiple speakers compared imitation butter to counterfeit money, asking why the government was willing to protect banks but not the "five million dairy farmers" throughout the country.[314] "We feel that Congress ought to step in and protect us against this counterfeit imitation of our product that is as injurious to us as the counterfeiting of coin or bank bills is to the banker," declared the head of the State Grange of Pennsylvania.[315] In a sermon in Evanston, Illinois in 1906, a church minister worried that the government was protecting a few wealthy manufacturers while farmers and consumers suffered. "There are other matters to be considered in legislation for pure foods than the convenience, the profits, or even the rights of the purveyors of foods, who are said to have their money involved in industries valued at hundreds of millions

[310] The manufacturer who hired these chemists was Walter S. Williams, a manufacturer of pickles, preserves and condiments in Detroit. Young, *Pure Food*, 212–13.
[311] Quoted in Young, 213.
[312] Young, 77,78.
[313] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 134 (statement of R.M. Littler). See also: Young, 80.
[314] Senator Robert La Follette similarly asked this question in a speech on oleomargarine in 1886. La Follete stated that rather than a special interest, protecting dairying was for the general welfare. "Nearly one-half of all the people of this country are engaged in and directly dependent upon agriculture […] From the standpoint of economics purely and upon the strictest business principles the interests of agriculture are the interests of this Government. No other pursuit so universally and profoundly concerns every other citizen of the Republic—no other calling known to civilized man, where so entirely and completely the interests of one is the interest of all." Senator La Follette (WI), speaking on June 2, 1886, 49th Cong., 1st sess., *Congressional Record*, appendix 225. See also: Young, 34.
[315] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 16 (Statement of Victor E. Piollet.) Several other speakers compared oleomargarine to counterfeit money. See: Ibid., 132, 265; Cohen, *Pure Adulteration*, 100–101.

of dollars," he proclaimed. "While these men have rights which should be guarded, there are 80,000,000 sons and daughters of God's family in this land who also have their rights. It is their right to have such access to the food supply as to be able to get wholesome food at a living price and know what they are getting."[316] The reverend questioned why the government was protecting the profits of a few corporations at the expense of what he defined as a consumer right to "wholesome food at a living price." Westerners and Midwesterners often pointed to the libel suits and upset manufacturers as evidence of the need for the laws. The Illinois newspaper that reported on this sermon praised Wisconsin's pure food law, reporting that the law "is creating not only a sentiment for wholesome products, but is causing alarm among the large manufacturers."[317]

The argument that the government was protecting a few corporations while ignoring millions of farmers also connected to a broader argument about industrialization, wage work, and farming. In the oleomargarine debates, George P. Lord, a former New York state senator, stated that though England had failed to account for their farmers, "England would sacrifice her entire agricultural industry if thereby she could secure cheap food for her half-paid and half-starved-employees. Thanks to a kind Providence our beloved America has not yet been brought down to the low level where the 'bloated' capitalists and their half-paid laborers are the only important factors that are worthy of consideration of those charged with the responsibility of Government."[318] Lord described a shift in wealth distribution with the decline of the agricultural industry and rise of wage work. L.I. Seaman, also of New York, warned that oleomargarine "can be produced by a handful of men and by a few manufacturers in as great quantities as can be produced by any of the largest dairying States within this Union," implying that the rise of this product will put many farmers and small producers out of work.[319] While these speakers explicitly argued for the law to defend the farming industry, just as the pure chemists accused them of doing, their argument was more complex than simply protecting one industry in the face of another. These speakers criticized the type of economic system based on wage work that was replacing the agrarian system. The main issue raised was that artificial foods allowed a few men to reap great profits while farmers lost ownership of production. Ladd and Jaffa both described the rise of food processors – or middlemen—as essentially stealing the profits of individual farmers, thus echoing populist arguments for farming cooperatives. "I presume that you, as well as the rest of us, know how hard it is to get farmers to cooperate;" Jaffa wrote in a private letter in 1906, "but when they do, it will be a sorry black day for the middle-men, who are now reaping a very profitable harvest on account of the non-cooperative of the farmer."[320]

While pure chemists like Atwater and Chandler argued that new food processors were providing cheap, nutritious foods for the new working class, agricultural chemists pointed to the societal costs of large food manufacturers, in both the declining livelihood of farmers and, they argued, the cheapening *quality* of food products. To the agricultural chemists, intense processing

[316] "Wisconsin Wins Pure Food Fight," *Chicago Daily Tribune*, February 26, 1906.
[317] Ibid.
[318] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 261 (statement of George P. Lord).
[319] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 4. Seaman continued by discussing how this would have a unique impact on the agricultural environment: "The production of butter is an adjunct to the crop of grass produced, one of the most important crops, as is admitted by learned men with whom I have talked, that there is raised, because grass produces our butter, our cheese, our milk, our beef, and our mutton, and is the food for man's helpmate, the horse, and an injury to wither one of these products affects in some degree the whole."
[320] Myer Jaffa to John Thomas, February 20, 1906, Jaffa Papers, Bancroft Library.

and coloring was primarily a strategy of deception, allowing manufacturers to disguise inferior food products and compete with producers of high-quality goods. With the bleaching of flour, Ladd claimed, "the farmer producing a superior wheat was being defrauded since his product was put in competition with an inferior article made to appear in the process of bleaching like the superior article." Emphasizing the potential of law to restore a high-quality food supply, Ladd described how, since North Dakota had prohibited bleaching, the state's wheat "has come again to be recognized as of superior quality."[321] Rather than providing cheaper and better products to the working class, Ladd argued that food manufacturers were simply gaining larger profits by using inferior ingredients. In his 1904 bulletin, Ladd cited manufacturers who used saccharin as a cheap substitute for sugar, "and yet these goods have not retailed at a less price than others of better grade put up under more sanitary conditions…Facts like the above are not stated by the manufacturers as an argument why the public should be served saccharin instead of sugar as an article of food."[322] While putting on the façade of helping the poor working class, manufacturers, Ladd argued, were really using cheaper and inferior ingredients to increase their own profits (in their less-than-sanitary factories, Ladd added).

The claim that artificial foods aided corporate profits more than consumer wallets was most often used in opposition to chemical preservatives. Agricultural chemists held a position distinct from the pure and industrial chemists in their insistence that chemical preservatives were entirely unnecessary. Plenty of jams, Ladd proclaimed, "do not contain benzoate of soda or any other chemical preservative…the use of a preservative in these products seems to meet a commercial convenience rather than being necessary as a food preservative where the fruits are prepared as preserves, jams and etc. while fresh."[323] Chemical preservatives were only needed when the fruits were not fresh, Ladd implied, and thus their main purpose was deception. With dairy, Jaffa similarly claimed that if the cow and its milk were cared for properly, "there [would be] no necessity for the use of preservatives to insure its keeping fresh."[324] Jaffa and Ladd insisted that new manufactured foods, substitutes, and chemical preservatives were simply not necessary, and only benefitting large food manufacturers.[325] They claimed that the increasing industrialization of the food system would lead to an increasingly degradation of the food supply as corporations constantly sought greater profits. In an undated lecture, Ladd spoke pessimistically about the state of food production since it left the home and community shop: "in the fierce battle for trade has come the cheapening of the cost of manufacture, a long search for substitutes, [and] attempts to imitate the real article by something cheaper and usually vastly inferior." [326]

Rather than providing cheap alternatives for the working class, proponents of strict pure food laws thought these alternatives were lowering the quality of food for the working class. Winthrop Stone, agricultural chemist and later president of Purdue University, made this point in a speech on pure food in 1896. "Usually fraud and deception and oppression falls hardest upon the poorer classes," he stated. "The working man who more than all else needs for himself and family

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[321] Edwin Ladd, "Report of the Food Commissioner, Part III: Waters, Wheats, Paints, Oils and Farm Products," *Twenty-Third Annual Report of the North Dakota Government Agricultural Experiment Station*, 296. Quoted in "Biographical Papers - H.L. Walster," 21, Ladd Family Papers.

[322] Ladd, *Adulteration Food Products and Food Studies*, 462.

[323] Ladd, 463.

[324] Archibald R. Ward and Myer E. Jaffa, *Pure Milk and the Public Health; a Manual of Milk and Dairy Inspection* (Ithaca, NY: Taylor & Carpenter, 1909), 188.

[325] Wiley also made this argument that clean facilities and proper procedures obviated the need for chemical preservatives. "All the difficulty about keeping catsup is a phantom," he stated. Young, *Pure Food*, 217.

[326] Undated lecture, Ladd Family Papers.

pure nutritious healthful food gets for his money that which has been rendered unfit and undesirable to nourish and sustain him. The effect of this upon his physical and moral condition is not to be estimated in dollars or cents."[327] As both Young and Cohen have noted, congressman O'Ferrall made a similar claim in the hearings on oleomargarine:

> Yes 'cheap food!' The stomachs of pigs, sheep, and calves reduced by acids, and then bromo-chloralum used to destroy the smell and prevent detection of the putrid mass…Yes, 'cheap food' in the shape of putrefaction rendered odorless by a powerful disinfectant. Yes, 'cheap food' in the form of an apothecary's shop in the poor man's stomach![328]

These arguments are reminiscent of the debate between Edward Atkinson and Eugene Debs discussed in the last chapter—in which Atkinson claimed science could provide working people with a cheap food options, and Debs insisted that workers did not want cheap food.

At the heart of the debate over pure food was that right the Evanston pastor emphasized – the right to "wholesome food at a living price." But who should define "wholesome food," and how should they define it? The pure chemists believed chemistry was the key – both in defining healthfulness and creating affordable food products, but the agricultural chemists questioned the motives of these arguments and the power of manufacturers in government. When a manufacturing association flexed their muscles, claiming their influence in congress would kill the pure food law if it prohibited chemical preservatives, Ladd expressed outrage. "In other words then," he declared, "this association proposes to dictate to the American people as to what chemicals they shall eat in their foods and to force legislation to their terms or to block all pure food legislations of this country."[329] The publicly-funded agricultural chemists claimed to be representatives of the people, fighting the ability of corporations to dictate the regulations. But how did the state chemists define wholesome food?

In April of 1900, William D. Hoard, former governor of Wisconsin and editor of *Hoard's Dairymen,* wrote to Atwater to contest his praise of oleomargarine, citing studies that had demonstrated that oleomargarine was injurious for the weak and sick. "More than this," Hoard wrote, "it seems to me common reasoning should teach us that a product left to the greed of unscrupulous men, aided by the skill of unconscionable chemists, can not and will not be as wholesome as a product designed by nature as a food."[330] Hoard played off populist arguments about "unscrupulous" corporations and the way "greed" was driving the development of new products, and unequivocally associated wholesomeness with "nature." While Hoard's statement might seem to be the antithesis of science, placing "common sense" and "nature" above quantitative chemical analysis as a measure of wholesomeness, many state chemists supported Hoard's claims in favor of "natural" foods.

Two features defined the arguments of agricultural scientists like Wiley, Jaffa, and Ladd who opposed the pure scientists in the debates over Pure Food: their holistic view of the food system and their skepticism of the limits of laboratory knowledge, which directly countered the scientific certainty and reductionism of pure chemists like Atwater, Chandler, and Johnson. Their

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[327] Winthrop Stone, [Speech on Food Adulteration], Indianapolis, May, 1896. Winthrop Stone Papers, Box 48, Purdue University Archives and Special Collections, Purdue University Libraries, West Lafayette, Indiana.
[328] Young, *Pure Food*, 84; Cohen, *Pure Adulteration*, 103.
[329] Ladd, *Adulteration Food Products and Food Studies*, 464.
[330] W.D. Hoard to Wilbur Atwater, April 23, 1900. Atwater Papers, Cornell.

role as counterbalancing corporate science and serving the people directly fed into their food system arguments, and reflected the populist rhetoric that was strong in western, agrarian states during this period. Witnessing the rise of large food manufacturers and the degrading livelihood of many farmers, they questioned the direction of the growing industrialization of the food system. Historians and scholars have generally assumed that the arguments of agricultural chemists rest purely on that – protecting their farming constituents, and thus these scholars portray the skepticism of artificial foods and support of natural foods as simply a biased, romantic, and emotional argument. The next section challenges and complicates this claim.

III. "You cannot prove it by chemistry"

Pure and industrial chemists were not the only ones to invoke scientific arguments in the debate. Rather than simply depending on nostalgia or romanticism, the forces against artificial foods presented scientific arguments to support skepticism of the wholesomeness of artificial foods. The caution expressed by Harvey Wiley at the beginning of this chapter, that the current state of scientific knowledge may be limited, exemplified a key line of attack by agricultural chemists on the value of oleomargarine. While Wiley could not use chemistry to argue that butter was superior, he suggested that "natural foods" might have "digestive advantages," or that some value may lie hidden in the "more complex composition" of butter. While chemists like Atwater and Chandler championed scientific certainty, Wiley and other agricultural chemists pointed to the limits of scientific knowledge, asking if there is something more in the complex structure of butter that "science has not yet been able to demonstrate." [331]

Rather than simply questioning science, these skeptical chemists employed scientific experiments and instruments to urge caution of artificial foods. Wiley used a microscope to see that butter had a more complex structure than oleomargarine, and included images from petri dishes in his bulletin.[332] One anti-margarine advocate described the microscopic structure of the substances in the hearing: "Butter is made of little globules, distinct and separate, like living globules, while oleomargarine and butterine are solvent, like wax or tallow, and therefore we say they do not assimilate with the system as butter does."[333] While Wiley assumed that butter had "digestive advantages" by virtue of being a "natural food," other chemists cited experiments that demonstrated the differing rates of digestibility of butter and oleomargarine. After describing this difference in digestibility, Professor Daniel E. Salmon of the USDA emphasized that fats and oils from different sources have different values: "It is reasonable to conclude from these facts that butter has an intrinsic value for food beyond that of lard, tallow, or cotton-seed oil, which might not be suspected from its chemical composition."[334] While the pure and industrial chemists argued that this difference in digestibility was negligible, scientists like Wiley and Salmon claimed that it pointed to the superiority of butter, or at the very least, to a reason to be cautious in the endorsement of artificial foods.[335] "I do not know, nor can anyone tell at this time, what the exact effect of an extensive use of oleomargarine will be upon the health of our people," said Professor Salmon. "There have been scientists here who have asserted positively that oleomargarine is just as wholesome, just as valuable, just as free from danger to health as pure butter. With this conclusion

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[331] Wiley, *Foods and Food Adulterants. Part First: Dairy Products*, 24.
[332] Wiley, Plates I-XII.
[333] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 6.
[334] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 213.
[335] Wilbur O. Atwater, "The Digestibility of Food: The Chemistry of Foods and Nutrition. IV," *Century Illustrated Magazine*, September 1887, 737.

I cannot concur," and thus, he argued, the consumer should be made aware of what they are eating.[336]

Scientists who were cautious about artificial foods emphasized that chemistry was just one component of nutrition. Another science, in fact, was as vital in assessing food values: physiology. Scientists who had endorsed oleomargarine as equal or superior to butter, as USDA microscopist Thomas Taylor claimed, "had given no consideration to its physiological relations."[337] B.F. Van Valkenburgh, the dairy commissioner of New York, asserted that though "by chemistry you cannot prove [oleomargarine] to be unhealthful," chemistry was not always the best measure of healthfulness. "If you take the blood from a small pox patient, a chemist may decide that it is not unhealthy, and yet if it is put in the veins of a healthy man, that man will have the small pox. Physiologically you can prove it to be unhealthy, but by chemistry you cannot," he explained.[338] Professor Albert B. Prescott, a chemist at the University of Michigan school of pharmacy, stated that he "[could]n't say" whether glucose was a wholesome food, as "the public have had very little opportunity to judge, because the consumer does not know when he is obtaining glucose and when he is obtaining some other sugar."[339] Prescott similarly noted that "what is a wholesome food for one man is not a wholesome food for another man" and that it "is difficult to find two stomachs that are alike;" thus, he argued, foods needed to be properly labelled.[340] Though scientists might be able to break down the chemical composition of foods, it did not follow that they could then deem the foods healthful or unhealthful.

Opponents of artificial foods similarly argued that just because an article had the same chemical components of a natural food did not mean it should be eaten. "Chemically there is no difference in the composition of cellulose as it is found existing in different plants, or between cellulose and starch," stated Professor Salmon, "but practically there is a great difference in the results of feeding animals upon sawdust, wheat, or oat straw, and young and tender plants."[341] Professor Salmon distinguished between defining foods chemically and practically. References to the chemical composition of non-food items, like sawdust, also provoked suspicion in artificial foods.[342] Senator Miller used this tactic in proclaiming that tallow is not "fit for anything but soap" and not a "proper article to put into anybody's stomach."[343] Van Valkenburgh pointed out that everyone agreed that raw fat is not wholesome, but that "you cannot prove it by chemistry."[344] In response to those who claimed that various scientists had verified that the "compounds [of oleomargarine are] healthful," G.P. Lord said he could not find "any intelligent man" who would

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336 U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 213.
337 U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 259. For a fascinating article on Taylor, see: J Kenneth Grace, "The Role of Thomas Taylor in the History of American Phytopathology," *Annual Review of Phytopathology* 26, no. 1 (1988): 25–29.
338 U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 22.
339 US Congress, Senate, Committee, *Adulteration of Food Products*, 56th Cong., 1st sess., 1900, 197.
340 Ibid., 198
341 U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products,* 211.
342 Benjamin Cohen describes a parody in *Puck* magazine in which the editors satirically advertised "Woodeo-Sawdusterine" – a new bread flour made of sawdust to feed the working class. They made clear their critique of advocates of margarine who said they had the poor's interest in mind. Cohen writes that many in the hearings "trumpeted the time-honored line that the poor and marginalized were hurt, not helped, by capitalist innovations in the dairy world." Cohen, *Pure Adulteration*, 102–3.
343 U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 24.
344 U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 22.

claim that "uncooked animal flesh is a safe food."[345] Articles that people defined as non-food items could have components that were identical to food, but they argued, it did not follow that they were healthful.

Advocates of natural foods further provoked suspicion of artificial foods by describing instances when injurious, "noxious" substances were found in the food. As Young notes, pure food crusader George T. Angell sensationally described

> meat butchered from diseased animals, flour milled from unwholesome grain, pickles dyed with copper salts, cayenne pepper tinted with red lead, confectionery colored with metallic dyes. Falsely labeled butter and cheese made from the fat and bones of diseased animals contained living parasites to 'enter and breed in human bodies.'[346]

A physician and chemist for the New York dairy commission claimed that his investigations showed that oleomargarine was not only "indigestible" but also "liable to carry the germs of disease into the human system."[347] Dr. R.U. Piper, an analytical chemist in Chicago, claimed to have found in his samples "various fungi," "living organisms," and "eggs resembling those of a tapeworm."[348] In an article, Piper included illustrations of his microscopic images of butter and oleomargarine and claimed that "good butter has none of these organisms" (Figures 11 and 12).[349] Professor Nachtrieb of the University of Minnesota noted that, in looking at various samples of butterine—including those that "had a butter odor and taste, and would readily pass for butter"—he had found mold, wood, hair, "portions of worms," a great "variety of life," and active bacteria. "The great number and variety of organisms found in the samples indicate the use of foul water and a criminal filthy process in making it," he stated.[350] Proponents of oleomargarine of course responded that it was possible to find germs or other noxious substances in butter, and these sensational accounts were clearly meant to provoke fear and suspicion of the unfamiliar industrial products. Using the microscope, they sought to show reasons to distrust the unfamiliar products of anonymous industrialists. Just as the reductionist chemist claimed that only a chemist could understand how oleomargarine is identical to butter, these chemists described finding harmful substances – like germs and parasites—invisible to the naked eye of the layman.

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[345] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 264. Note the use of the word "compound" here. One similar tactic to describing non-food items in artificial foods was to highlight that manufactured foods were just that—manufactured by chemists in a factory setting. Sometimes pure food advocates would depict a cauldron brewing margarine, and indeed, Congressman Henderson of Iowa quoted the scene of three witches around a cauldron in Macbeth as "the process of making oleomargarine." Henderson, speaking on May 25, 1886, 49th Cong., 1st sess., *Congressional Record*, 4905. See also: Cohen, *Pure Adulteration*, 11. Sometimes these descriptions were less dramatic. Myer Jaffa, for example, wrote: "When people call for a certain kind of fruit jelly they don't want to be given a compound prepared from a chemist's formula and containing a lie on the label." "Food Adulterants," *San Francisco Call,* Volume 82, Number 48, July 18, 1897, 22. California Digital Newspaper Collection.

[346] Young, *Pure Food*, 47.

[347] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 23 (statement of Van Valkenburgh citing R.D. Clark of Albany).

[348] "Debate on Adulteration," 125.

[349] "Though Shalt Not Adulterate," *The American Bee Journal* volume XV, No. 4 (Chicago), April, 1879, 48-49.

[350] Congressional record, May 25, 1886, 4939. Young references this report as well. Young, *Pure Food*, 85.

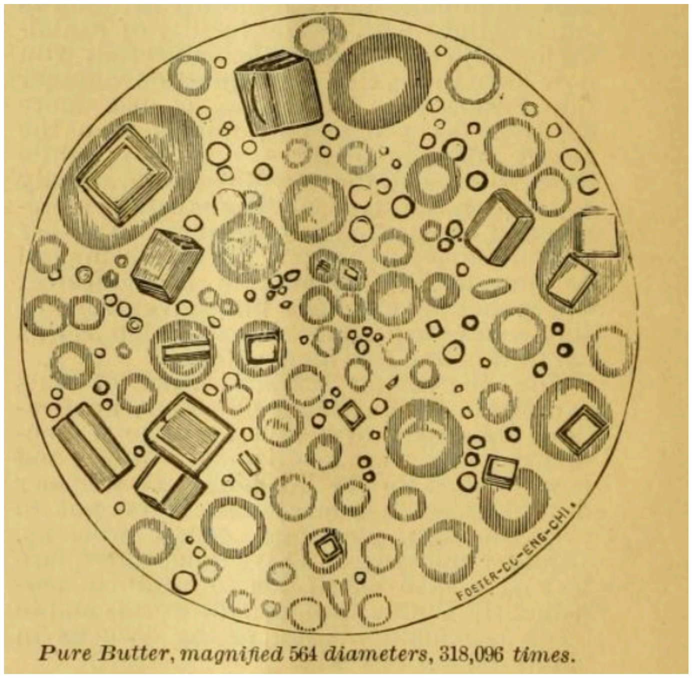

Figure 11: "Pure Butter, magnified 564 diameters, 318096 times," in "Though Shalt Not Adulterate," *The American Bee Journal* volume XV, No. 4 (Chicago), April, 1879, 48.

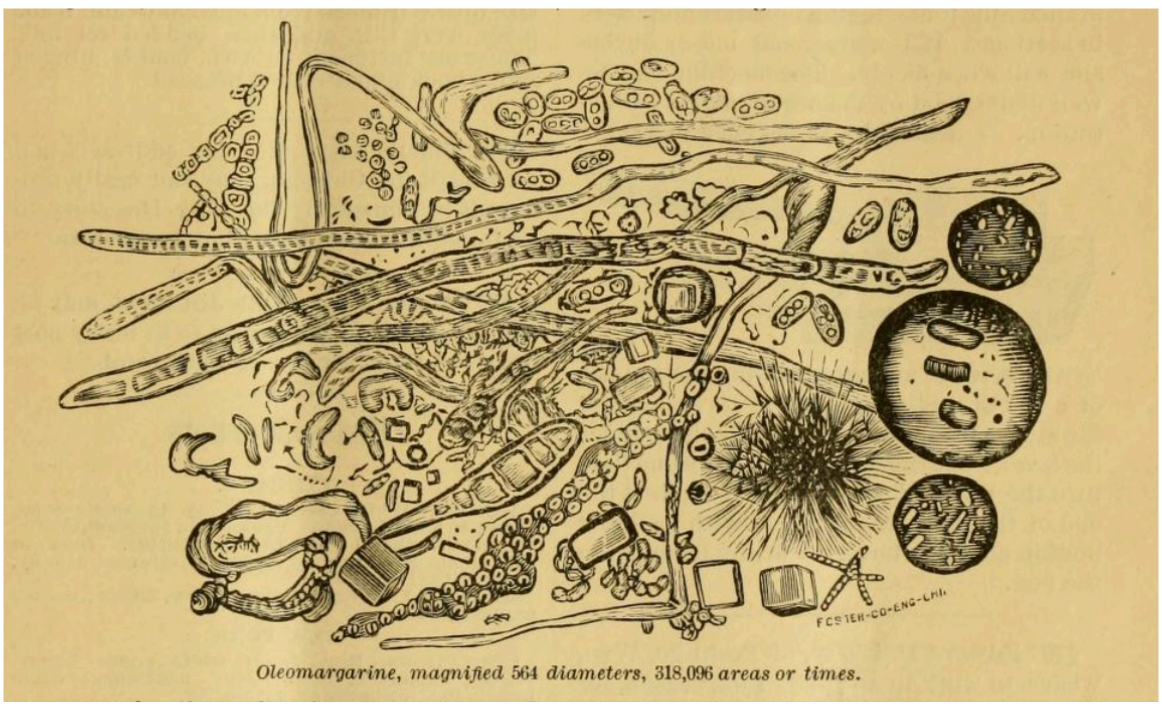

Figure 12: "Oleomargarine, magnified 564 diameters, 318096 areas or times," in "Though Shalt Not Adulterate," *The American Bee Journal* volume XV, No. 4 (Chicago), April, 1879, 49.

In describing noxious substances and the chemical similarities of foods to non-food items, the "natural" food advocates invoked feelings of disgust in the industrializing food system, and called on consumers to follow their own internal logic in dietary choice. At times speakers even cited the widespread aversion to oleomargarine as *evidence* of its harmfulness. "In regard to the unwholesomeness of these foods, I will say…that scarcely any of the families in the United States will knowingly buy them," said one opponent.[351] Others listed as evidence hospitals that refused to give oleomargarine to patients, countries like France that had regulated its use, and physicians and even the manufacturers of the products themselves who would not eat it.[352] "The stuff is nauseating to the average man, and I contend cannot be wholesome," another speaker asserted.[353] "After science has done its best or its worst, after all the laboratories have exhausted themselves," said Congressman William Adamson of Georgia, "in the last analysis it will be proved that the old ladies in the home, the housewives, the old cook …knew more about the subject than all science and all scientists."[354] Perhaps common sense or traditional knowledge of food, these speakers argued, was more useful in deciding what was healthful than consulting a chemist.

Though disgust would play a powerful role in the passage of the Pure Food and Drug Act, particularly with Upton Sinclair's *The Jungle*, both sides of the debate recognized that disgust alone is not an accurate measure of healthfulness. "We eat things that formerly were disgusting to us," said Senator Henry Blair of New Hampshire, in arguing that oleomargarine should be dyed red or blue. "The Frenchman eats frogs, and we would soon become accustomed to them."[355] This is similar to Morton's earlier statement on taste and habits, as Morton argued that prejudice against oleomargarine was from habit. Both sides recognized that culture and custom shaped taste and disgust, but they used this argument for different ends: the artificial food advocates to claim that requiring certain labels or coloring of artificial foods created an unscientific aversion toward the items, and the proponents of natural foods to claim that, as culture and customs can change, consumers will adjust to foods that are dyed and labelled if they choose to consume those foods. While the artificial food advocates chastised the public for their irrational feelings of disgust, the natural food advocates upheld the idea that food companies should not trick people into eating something they might find disgusting, emphasizing the importance of this emotion in consumer choice.

This appeal to emotion and culture could also be seen in the use of the word "nature." While artificial foods provoked suspicion and disgust, natural foods espoused familiarity and nostalgia. In the oleomargarine debates, technical arguments about the chemical composition of butter easily slid into romantic claims about natural processes. At the 1886 hearings, an Iowa farmer stated that to understand its superiority, one has to "get at the chemistry of butter…in butter-fat we have oils that are not found in anything else but mother's milk. The milk and the butter-fat oils are the first and last food of man."[356] This farmer used chemistry to demonstrate that butter is associated with a natural food that industrial scientists were attempting to replicate—mother's

[351] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 6 (statement by L.I. Seaman).
[352] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 6 (statement of Joseph H. Reall), 211-221 (statement of Prof. D.E. Salmon).
[353] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 269 (statement of James Hewes).
[354] William Adamson (GA), speaking on December 18, 1902, 57th Cong., 2nd sess., *Congressional Record,* 437. Quoted in: Young, *Pure Food*, 163.
[355] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 94 (statement of Henry W. Blair (NH)).
[356] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 138.

milk.[357] Others invoked a pastoral idealism to promote the superiority of natural foods. In the 1882 hearings on oleomargarine, Congressman Jacobs claimed the consumer "hears the praises of the product of the French patent, but he longs for the fruits of God's patent, the pure spring water, the sweet grasses, and the lowing herd."[358] Jacobs depicted an idyllic and blessed landscape to support the natural food. Some also connected ideas about civilization and national identity to the use of butter and other so-called natural foods. Congressman Grout of Vermont worried that the move to oleomargarine would threaten Americans as "a butter eating people, taking a step backward toward the raw tallow and lard which were the delight of our Saxon ancestors in the forests of Germany."[359] Butter represented the bounty of nature, the pastoral landscape, the fluid of vitality, the marker of civilization, and a distinctly American identity.[360]

The agricultural scientists defined "pure food" as natural or traditional products, contradicting the pure and industrial chemists who connected purity to chemical components. "I really don't see, ladies and gentlemen, how I can be expected to know much about pure food," said David Starr Jordan, president of Stanford University at a meeting on the Pure Food Laws in California, "since I haven't met with any since I left the farm."[361] In a lecture on food adulteration, Jaffa stated that "no element should be introduced into the system that is not naturally found there, and the antiseptics most commonly used—salicylic acid, sulphurous [sic] acid, boracic acid and formalin or callerin [sic] —'are not found there unless introduced by the ignorance or dishonesty of man,'" a newspaper reported.[362] These scientists claimed that a product was no longer a "pure" food if it included new ingredients and preservatives, whether or not they were deemed immediately harmful. "It must not be forgotten, too, that even though adulterated with matter not positively injurious to health," Wedderburn claimed in his 1890 bulletin on food adulterants, "such food, drugs, or liquors can not be as nutritious and wholesome as the pure articles."[363] Wiley insisted that a chemist simply could not reproduce nature's combinations: "Synthetically, of everything made by man, almost nothing has the hygienic value of that made by nature."[364]

While the arguments for foods "made by nature" seemed to epitomize an unscientific, backwards point of view, agricultural chemists connected cultural food values and natural foods to scientific method. These chemists emphasized that chemistry alone could not determine the healthfulness or harmfulness of a food; only physiological tests could ensure the safety of a new food item. The use of a food for generations, they argued, provided the physiological experiments to support the use of natural foods –meanwhile new artificial foods had little to no physiological experiments to verify their safety for long-term health. Some pure food advocates raised the

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[357] For reasons of time and space, and for my particular interest in agriculture, I did not discuss the rise of infant formula in this dissertation. For work on infant formula and infant feeding more generally, see: Rima D. Apple, *Mothers and Medicine a Social History of Infant Feeding, 1890-1950* (Madison: University of Wisconsin Press, 1987); Amy Bentley, *Inventing Baby Food* (University of California Press, 2014).

[358] Quoted in: Young, *Pure Food*, 75. Cohen notes this romantic use of the idea of butter as "natural" as well. He quotes one Philadelphia milk advertisement which read: "Nature, the Original Chemist, yields the secrets of its Laboratory grudgingly—without experiment or guesswork, its products are perfect." Cohen, *Pure Adulteration*, 101.

[359] Quoted in: Young, *Pure Food*, 84.

[360] Virginia Anderson provides an early history of the way that livestock and dairying represented a civilizing force in America. Virginia DeJohn Anderson, *Creatures of Empire: How Domestic Animals Transformed Early America* (New York: Oxford University Press, 2006).

[361] "The Bad Food Evil," *The Evening Post* (San Francisco), May 1, 1897. Jaffa Papers, Bancroft Library.

[362] "Food Adulterants," *San Francisco Call,* Volume 82, Number 48, July 18, 1897, 22. California Digital Newspaper Collection.

[363] Wedderburn, *A Popular Treatise of the Extent and Character of Food Adulterations*, 7–8.

[364] Young, *Pure Food*, 216.

question of whether the consumption of new foods, such as glucose, was contributing to rising rates of dyspepsia (or indigestion), kidney disease, or diabetes.[365] When the chairman of the hearings on oleomargarine asked a chemist in favor of the product, James F. Babcock, whether he had made physiological experiments on artificial foods, he answered that "the public has been making them for ten years" and nobody had died of oleomargarine.[366] Moreover, he claimed, people knew that bread was wholesome without any experiments to prove it. To that, the Chairman responded, "You could probably point to the experiments which have been going on for a thousand years…In regard to oleomargarine, we have not had that sort of experience yet."[367] The argument for natural foods was based in physiological experiments that had taken place for "a thousand years."

The lack of long-term physiological experiments of new industrial foods was a reason many agricultural chemists urged caution of the products, and they argued that these ingredients should not be added to the food supply until experiments were made. "It would seem that, in the light of our present knowledge," Jaffa wrote on new chemical preservatives, "it would be far safer to prohibit the use of preservatives in foods or food materials. If, later on, science can show, as some claim it will, that the small addition of certain preservatives are harmless, then the laws can be modified accordingly."[368] A new ingredient, as Jaffa noted, should not be added to the food supply simply based on its chemical properties; physiological experiments were needed to prove their harmlessness first.

The scientific argument against artificial foods mostly depended on caution of the unknown. Chemists could show that there were differences between the natural and artificial foods in microscopic structures and digestibility, thus demonstrating the limits of scientific knowledge, and they could prove that natural foods were healthful from generations of experimentation, but they did not have evidence to *prove* that artificial foods were harmful to health. Chemists in favor of artificial foods like James Babcock claimed that you could prove healthfulness by feeding artificial foods to a dog, but others questioned this assertion. "If you take a food product and analyze it and find no known poison in it, then you can give a scientific and absolute opinion as to the healthfulness or unhealthfulness of it," one congressman said, "but is it not necessary that there should be a long experiment in the use of that article, as food, in order to determine what its ultimate effects on the human system will be?"[369] As much as they might demonstrate the limits of scientific knowledge or urge caution with industrial foods, agricultural chemists could not prove that they were less wholesome than natural foods without a long-term test on humans that showed negative effects.

Due to the lack of scientific evidence to prove the harmfulness of artificial foods, by 1900, Wiley had stopped arguing that natural foods were more wholesome than substitutes, imitations, and new processed foods. However, this did not mean he now portrayed the foods as equal.

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[365] For example: Various speakers raised the question of whether increased glucose intake was causing kidney diseases in U.S. Congress, House of Representatives, *Adulteration of Food: Report (to Accompany H.R. 7005)* Congressional Report No. 199, 46th Cong., 3rd sess., February 4, 1881, H.rp.199. In the 1886 hearings, Victor Piollet of the State Grange of Pennsylvania stated that he thought sulphuric acid used in making glucose had caused an increase in kidney disease and diabetes in his community, and D.E. Salmon said of the digestibility of butter and butter substitutes: "This is a matter of great concern to a nation which is said to be rapidly becoming a nation of dyspeptics." U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products,* 15 (statement of Victor Piollet), 212 (statement of D.E. Salmon).

[366] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 90.

[367] Ibid., 91.

[368] Myer E. Jaffa, "Pure Food Law," *California State Journal of Medicine* II, no. 6 (June 1904): 180.

[369] U.S. Congress, Senate, Committee, *Testimony in Regard to… Imitation Dairy Products*, 90.

Interestingly, in the 1900 congressional hearings on food adulteration, each time Wiley seemingly endorsed an "artificial" food as wholesome and nutritious, he followed by saying that he personally preferred the taste of the natural or traditional food item. In discussing filled cheese—cheese that is made with skimmed milk with a cheaper form of fat, such as vegetable oil—Wiley admitted that food was fraudulent "from a financial point of view" rather than injurious to health, stating that "the added fats are usually pure and wholesome." However, he followed by stating: "The cheese which are made with these added fats are also to my taste less palatable and less desirable in every way then those made from whole milk, although I could not say that they are less nutritious."[370] On the adulteration of olive oil with cotton seed oil, he stated: "Now, for the purposes of sale as far as food value is concerned, there can be no choice between the two bodies. Personally I prefer the flavor of the olive oil, but that is matter taste."[371] Vinegars imitating apple cider vinegar were "wholesome, but the flavor is not as good as the flavor of apple; the cider gives it a better flavor. You get an artificial flavor in the low wine product."[372] Wiley brought values outside of chemical components and nutrients—values of pleasure and culture—into the Pure Food hearings. And though seemingly unscientific, at this time, taste was viewed as an important factor in digestion. Artificial mixtures may have had the same chemical components of traditional or natural food, but Wiley consistently stated that they could to capture the superior flavor of natural foods, though he always stated this as a personal preference.[373]

Still, Wiley remained convinced that one type of artificial food would have long-term harmful effects on the human system: chemical preservatives. Wiley insisted that chemicals that prevent food decay would similarly inhibit digestive processes: "There is no preservative which paralyzes the ferments which create decay that does not at the same time paralyze to an equal degree the ferments that produce digestion," Wiley argued.[374] Jaffa repeated this claim in a lecture in 1897, adding that "They are of course especially dangerous for invalids and persons of weak digestion."[375] A.S. Mitchell of the University of Wisconsin similarly claimed that antiseptics were "necessarily deleterious to health" because they stopped the normal workings of digestion, and testified that chemical preservatives were advertised to manufacturers for their ability to avoid "detection by chemists."[376] Not only were the chemical preservatives themselves potentially harmful, but, these chemists claimed, they also "invite[d] the use of certain grades of food which otherwise […] the consumer would reject," stated Professor Prescott of the University of Michigan.[377]

Surprisingly the chemists in favor of chemical preservatives used similar tactics as the earlier natural food advocates, arguing that the preservatives came from "nature." One hotly contested preservative – benzoate of soda –was found in high amounts in cranberries. "It seems to

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370 U.S. Congress, Senate, Committee, *Adulteration of Food Products*, 56th Cong., 1st sess., 14.
371 Ibid., 16.
372 Ibid., 25.
373 Cohen also describes how, for Wiley, as long as it was properly labelled, the use of cottonseed oil "was a matter of taste, not health." Cohen, *Pure Adulteration*, 136–37. In a recent biography of Wiley, Jonathan Rees claims that, though Wiley wrote of this little publicly, taste may have shaped his ideas of "pure" food. Wiley was known as someone who loved food and, Rees argues, seemed to focus work on foods that he enjoyed eating. He writes: "While he seldom admitted it in public, Wiley's ideas about how a particular food should taste often affected whether or not he thought that food was healthy and pure." Rees, *The Chemistry of Fear*, 6–7.
374 Quoted in Young, *Pure Food*, 143.
375 "Food Adulterants," *San Francisco Call,* Volume 82, Number 48, July 18, 1897, 22. California Digital Newspaper Collection.
376 U.S. Congress, Senate, Committee, *Adulteration of Food Products*, 56th Cong., 1st sess., 111.
377 U.S. Congress, Senate, Committee, *Adulteration of Food Products*, 56th Cong., 1st sess., 195.

me that if the Almighty put it there, the manufacturer ought to be allowed to use it," said one packer at the hearings, echoing earlier arguments for the merits of butter as "the fruits of God's patent."[378] A manufacturing chemist similarly highlighted the importance of generations of food selection to argue for the preservative's healthfulness. "While I am a respecter of science, I believe in the selective capacity of man; I confess to having more confidence in man selecting in the course of centuries the right thing than scientists pointing the right way," declared the manufacturing chemist. "For instance, it has been found that […cranberries have] been used for a long time without any apparent injurious effects. I should say that that is better proof than any physiological test which may cover a few weeks or months."[379] Yet, even after finding that in small amounts of boric acid "[produced] no measurable effect that could be spoken of as deleterious," a leading pure chemist of the era, Chittenden, remained cautious of its use.[380] Wiley responded by claiming that the possible injuries "did 'not occur to such a degree when nature puts deleterious substances in food' as when man does," as Young notes. He also questioned whether the chemical in cranberries *did* tax the body, and whether the addition of the chemical to daily fare may produce "subtle injury which time will tell."[381] Here as elsewhere in the pure food debates, the importance of time in measuring healthfulness was emphasized.

The manufacturing chemist's reference to the invalidity of a physiological test which "may cover a few weeks or months" was likely a reference to an investigation conducted by Wiley to measure the impact of chemical preservatives on health. In 1902, Wiley set out to provide a physiological experiment that would demonstrate the relative harmfulness or healthfulness of chemical preservatives, an experiment that would attract widespread public attention. Wiley, and other agricultural chemists, hoped it would conclusively show the harmfulness of preservatives.[382] In the experiment, a group of healthy young men volunteered to consume increasing amounts of chemical preservatives with their meals each day. Dubbed the "Poison Squad" in the national press, the group submitted to physical exams and chemical analysis each day before and after meals. As the preservatives increased, the group reported lack of appetite, stomach pains, inability to work, and weight loss. "I was converted by my own investigations," Wiley declared when ask about his certainty of the harmfulness of chemical preservatives. Wiley published his results as Bulletin 84 in six parts beginning in 1904, and in 1907, borax was prohibited from being used in food manufacturing.[383]

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378 Quoted in Young, "The Science and Morals of Metabolism: Catsup and Benzoate of Soda," 92.

379 Ibid. Young describes pro-chemical-preservative forces who turned around arguments that compared artificial foods to non-food items, by pointing out that traditional preservatives were used to mummify pharaohs, and that vinegar could also be used to mask rotting food (92).

380 Quoted in Young, *Pure Food*, 144. Surprisingly, given Chittenden's earlier criticism of dietary surveys and faith in laboratory research, Chittenden in fact argued for a *more* restrictive regulation of zinc and copper salts used in canning than Wiley. These salts were used to preserve the greenness of peas, and Chittenden thus saw it as an unnecessary and fraudulent practice.

381 Young, 216.

382 Myer Jaffa wrote several letters to Wiley on this experiment: "I see in the papers that you have commenced another series of experiments with your young men. I wish you the best of luck," he wrote in 1903. After Wiley published Bulletin 84, seeming to demonstrate harmful effects of preservatives, Jaffa wrote, "I want to congratulate you and your associates on Bulletin 84. It is certainly a most valuable and interesting piece of work and very important addition to our knowledge on the effect of preservatives on health and digestion." Myer Jaffa to Harvey Wiley, October 16, 1903; Myer Jaffa to Harvey Wiley, March 6, 1905, Records of the Bureau of Industrial and Agricultural Chemists, Letters Received, 1886-1906, National Archives, College Park, MD.

383 Rees, *The Chemistry of Fear*, 90; Harvey W. Wiley, *Influence of Food Preservatives and Artificial Colors on Digestion and Health. I. Boric Acid and Borax.*, USDA Bureau of Chemistry Bulletin 84 (Washington DC: Government Printing Office, 1904).

As Young describes in his article on benzoate of soda and the Poison Squad, this prohibition did not last long. Wiley's experiment lacked many controls that would invalidate his results today. There was no control group to demonstrate that other factors weren't producing the symptoms, and the participants consumed the preservatives in capsules, rather than mixed in with their food. The simple knowledge of eating a potentially harmful substance may have produced some of the symptoms, such as stomach pain and loss of appetite. In response, the head of the Department of Agriculture organized a board of experts to conduct a second experiment. Called the "Remsen Board" after Ira Remsen of Johns Hopkins, this group of scientists conducted three separate studies. Though also imperfect by today's standards, the experimenters attempted to create more controls than were used in Wiley's experiment, including mixing the preservatives into the food, and not telling the participants when the trial period began and ended.[384] Young argues that the defining difference between Wiley and the Remsen Board, however, was in their interpretation of the data rather than in their method: where Wiley saw a significant impact on health, the Remsen Board saw "normal variability." The Remsen Board concluded that the preservatives were harmless, though they admitted that the chemicals did cause "slight modifications in certain physiological processes, the exact significance of which modifications is not known."[385]

Siding with the Remsen Board's conclusions, the USDA removed the ban on benzoate of soda, but the controversy within the scientific community continued. While most university and institute research scientists and some of Wiley's colleagues in government agreed with Remsen, "many state chemists and food officials took a firm position against benzoate." Both experiments were accused of having faulty research designs, and both sides were accused of prejudice. The state chemists were accused of a farming prejudice, and the pure chemists of a manufacturing prejudice. One critic suggested that "all university professors were pro-industry…because industry provided key sources of university funds." This controversy eventually led to Wiley's resignation from the USDA in 1912. Though later experiments supported the Remsen Board's conclusions, Young observes that Wiley's experiment created a precedent for demonstrating food safety. "Half a century later, the Congress enacted into law the principle Wiley advocated, that food processors must prove that proposed food additives are safe before they may be placed in the diet of the American people."[386]

"A demonstration that a thing is harmless is an impossible demonstration," Wiley wrote in a letter in 1910. "All that could be said would be that in the quantities given, over a time given, to the people given, it had produced no deleterious results."[387] Agricultural chemists could not prove that artificial foods were harmful, but they argued the pure chemists could not prove they were harmless. The chemical components of food, which pure and manufacturing chemists insisted were enough to verify food safety and even make artificial and natural foods identical, could not determine the safety of a food, as many known harmful substances shared chemical components with foods. Natural and traditionally processed foods, on the other hand, had generations of physiological testing to ensure their safety. Agricultural chemists were cautious where pure and manufacturing chemists were certain; they were holistic in their thinking about nutrition and food systems where pure and manufacturing chemists were reductionist and narrow.

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[384]The board included: Russell Chittenden of Yale, Christian Herter of Columbia, John Harper Long of Northwestern, and Alonzo Taylor of California. Taylor ended up being head of research in the US Food Administration during WWI, discussed in Chapter 4.
[385] Quoted in Young, "The Science and Morals of Metabolism: Catsup and Benzoate of Soda," 98.
[386] Young, 104.
[387] Quoted in Young, 101–2.

Their caution in science did not equate to being anti-science or unscientific. In fact, agricultural chemists consistently expressed an optimistic faith in the advancement of science to ensure a safe and healthy food system. In 1915, as president of the Association of Agricultural Chemists, Ladd spoke admiringly of how regulatory laws had given rise to more advanced fields of chemistry, allowing the state chemist to call upon "the physical chemist, the biological chemist, the micro chemist, the toxicologist, the physiologist, the bacteriologist, in fact, upon the whole realm of science to bring to bear their skill and knowledge in solving the problems of the people and to hold the prestige that is ours as workers in this great field now spread out before us."[388] Ladd praised the way food safety could bring together different fields, the way it required a holistic view of food and health. Even as they urged caution of new artificial foods, the agricultural chemists were forward-looking in their faith in scientific progress, rather than backwards or romantic in the way scholars have characterized them and agrarian movements of this period.[389] Ladd once described a very futuristic vision of food, writing that the day will come when the knowledge of the chemistry of foods is so advanced and widespread that "our foods will be scientifically prepared, in food laboratories, and adapted to the varying wants of the individual—then our homes will be without a kitchen in its present significance. Then gout, rheumatism, dyspepsia, indigestion, bilious attacks, Bright's disease, croup, rickets, etc., will be nearly or quite unknown among the more intelligent classes."[390] The agricultural chemists emphasized that food science was in its infancy, that it had room to advance and continue to build and secure a safe food system, particularly in its ability to identify and regulate unscrupulous forces. "It is of more than passing interest, and certainly a matter of congratulation," wrote Myer Jaffa, "to be able to say that the greater the advance of science, the greater and more powerful is the ammunition brought forward to fight, and successfully too, the advocates of the use of deleterious materials in our food products."[391]

There is a way in which their caution of new foods came from this faith in scientific progress; they believed they were just beginning to understand the chemistry of foods and science of nutrition, and it was too early to assume they could add something new to the food supply based on this incomplete knowledge. This faith in science went hand-in-hand with a faith in consumer education. Caution was not enough to determine the law at this point, and without evidence of harmfulness, arguments for substances to be dyed, taxed, or prohibited were seen as unfair and prejudiced. In the end, the main requirement of the Pure Food and Drug Act of 1906 was labelling. By 1906, agricultural chemists expressed confidence that when labelled, consumers would choose pure over artificial foods, even if artificial foods were cheaper. "The public are fast coming to demand pure food products," Ladd wrote in 1904, "and they are willing to pay for the same." Jaffa consistently ended his articles and lectures on pure food with a call to consumer action: "When the public is properly educated on the subject, and people begin to desire pure food furnished to them in its best form - then, will food laboratories be established and properly maintained; *then* will food laws be strictly enforced and food adulteration become a practice of the past."[392] While they

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388 Edwin Ladd, "President's Address," *Journal of the Association of Official Agricultural Chemists*, Vol. 1, No. 3, November, 1915, 515.

389 See discussion of this trend in the historiography in Postel, *The Populist Vision*.

390 Edwin F. Ladd, "Some Thoughts on Foods," *The Sanitary Home*, May 1899, 61.

391 Ward and Jaffa, *Pure Milk and the Public Health; a Manual of Milk and Dairy Inspection*, 187.

392 Jaffa, "Pure Food Law," 182. When Jaffa spoke against the use of "dangerous sulphurous acid" used to color dried fruit, he similarly stressed that consumers needed to be educated. He noted that farmers did not use the substance on the dried fruit that they kept for home consumption, but they added it to what they sold in the market due to consumer demand (it "would be ruinous" to their interests not to, Jaffa said). "The minds of dwellers in cities should be

held a holistic view of food production, agricultural chemists seemed to have shared a narrow view of consumer choice with their pure and industrial counterparts: education and science could rise above other factors such as money, time, and access to sway consumer choice. Agricultural chemists expressed the belief that labeling combined with consumer education would make artificial foods—from food coloring to preservatives to imitation foods, which they argued were simply deceiving consumers into buying poor quality products—a thing of the past.

IV. Conclusion: Beaten and Baffled

In 1905, Robert G. Eccles, a physician, chemist, professor of organic chemistry, and one of the leading developers in using benzoic acid as a preservative, published research in favor of the use of chemical preservatives in food.[393] He began by addressing the critics of chemical preservatives, characterizing them as a conservative people who "dread changes of every kind," particularly when it came to "what they eat and drink."[394] According to Eccles, these critics were essentially unscientific: romantic, backwards-looking, and holding "strange notions about what ought to be deemed wholesome and what unwholesome."[395] Eccles claimed that this group had influenced a segment of scientists, who "possess[ed] a burning desire to favor the notions of the conservative, to appear as public benefactors, and to show themselves as efficient guardians of the trusts that have been imposed upon them," Eccles wrote, clearly aiming at publicly-funded agricultural chemists.[396] Politics had influenced the views of chemical preservatives in France and Germany as well, Eccles lamented, where "political passion had usurped the place of scientific dispassion."[397] While the motives against chemical preservatives might have been "thoroughly honorable and upright," he wrote, "we deprecate, just the same, a result which we deem unfortunate and antagonistic to the best interests of humanity."[398] Motivated by service to the public, the chemists, Eccles claimed, had taken on a decidedly unscientific viewpoint. There was not "an iota of experimental evidence" to support their claims.[399]

Not only were the agricultural chemists unscientific due to their bias as public servants, Eccles argued, but they were distinctly anti-science in their belief in the superiority of natural or traditional foods. "To us, it seems unreasonable to believe that the savages could have discovered the only really safe preservatives in the universe," Eccles wrote incredulously,

> To even acknowledge that they discovered the best food preservatives that nature can provide seems contrary to all analogy. That modern science, after years of special study in this very field, should emerge from its work beaten and baffled, and be compelled to acknowledge that Apaches, Bedouins, Tartars, and

disabused of this false idea," Jaffa declared, that the light-colored dried fruit was cleaner and more healthful. "Food Adulterants," *San Francisco Call,* Volume 82, Number 48, July 18, 1897, 22. California Digital Newspaper Collection.

393 Eccles testified during the pure food debates, where he went so far as to argue that the use of formaldehyde in milk reduced infant mortality. Young, *Pure Food*, 213–14.

394 Robert G. Eccles, *Food Preservatives: Their Advantages and Proper Use, the Practical versus the Theoretical Side of the Pure Food Problem* (New York: D. Van Nostrand Co., 1905), 1.

395 Eccles.

396 Eccles.

397 Eccles, 3.

398 Eccles, 2.

399 Eccles, 3.

> Mongolians had wrenched all the prizes before they began their research, requires a very great stretch of credulity.[400]

According to Eccles, to argue natural or traditional foods were superior to artificial foods was to reject modern science. The idea that chemists should look to "savages" –markedly non-white in Eccles' description –was against Eccles' very idea of scientific advancement. What a break from the early claims of Atwater about how different peoples of the world had developed food systems that perfectly met their nutritional needs, and what a change from looking to different food systems to understand the components of healthful diets, as agricultural chemists did in the dietary surveys! Eccles expressed a certainty that modern science had found the answers and that modern science should direct the food system, a certainty that we saw expressed by pure and industrial scientists throughout the pure food debates. Eccles took Chittenden's earlier questioning of the use of dietary observations to assess dietary standards to an extreme – one that even Chittenden may have questioned.[401] Eccles characterized the agricultural chemists' caution of new products, skepticism of the state of scientific knowledge, and insistence for the need of long-term physiological experiments, as simply a claim that "the only safe food preservatives are the ones handed down to us from the barbarous and ignorant past."[402] Writing that he hoped his book could correct these "time-honored errors," Eccles expressed his pleasure in watching "the changing attitude of scientific men in this direction [in favor of chemical preservatives]."[403]

Eccles was right to recognize a changing attitude of scientists. Because agricultural chemists could not prove that artificial products were harmful, many scientists stopped using health concerns to argue for their regulation. Between the oleomargarine debates of the 1880s and the passage of the Pure Food and Drug Act in 1906, chemists also seemed to shift from a moral-economy argument about regulating counterfeit food in order to protect farmers to a focus on consumer safety and labelling. Perhaps it was the idea that science required "dispassion" separate from "passionate politics" that narrowed this focus from a food-systems approach to a consumer focus, or perhaps is was from outside changes with the rise of agribusinesses and increasing urbanization.

It is possible that the decline in the farming population and rise in urban consumers caused a shift in the research focus of state agricultural chemists. Temporality, however, seems to have been one of the largest factors. Despite the warnings of agricultural scientists that one cannot judge the health effects of a new product without a long-term experiment, which traditional and natural products had undergone through generations, regulations would be made based on short-term laboratory results for decades to come. It may be that the temporality of the agricultural chemists did not match the industrial time of the era.

Though the agricultural chemists' perspective weakened leading up to the Pure Food and Drug Act, it is a mistake to look at the Pure Food Movement as solely a consumer rights movement or a technocratic movement. The Pure Food Movement was a populist, agrarian movement as well, and not in the outdated understanding of populism as backwards or romantic, but in the sense

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[400] Eccles, *Food Preservatives: Their Advantages and Proper Use, the Practical versus the Theoretical Side of the Pure Food Problem*, 2.
[401] See Chittenden's caution about dyes in canning, discussed in footnote 380.
[402] Eccles, *Food Preservatives: Their Advantages and Proper Use, the Practical versus the Theoretical Side of the Pure Food Problem*, 2.
[403] Eccles, 4. Pure food should not be defined by tradition or nature, Eccles insisted. "While heartily in favor of pure-food legislation, the opposition to modern preservatives seemed to be in favor of impure food and foods dangerous to public health."

that public scientists and farmers attempted to curb the power of large corporations and promote a food supply based on natural foods. Chemists during this era are usually portrayed as working hand-in-hand with the food industry to create a system in which food processes became hidden from consumers, but the agricultural chemists complicate this characterization. Instead, agricultural chemists used science to make visible the types of adulteration and processing that were hidden from consumers. From this perspective, the growing role of chemists in regulating food might be better understood as a response to the industrializing food system rather than a promoter of it. Food values tied to nature, culture, and tradition were already under threat in this new food system, and some researchers sought to use science to support these values.

Chapter 3: "Common Sense Farmer Knowledge" and the Discovery of Vitamins
Skepticism, Industrialization, Animals, and the Historical Distortion of a Paradigm Shift

Perhaps the largest paradigm shift in the history of nutrition science in the United States is said to have begun with a joke, a joke with iterations that reverberated throughout the pure food debates. The jokester was agricultural chemist Stephen Moulton Babcock. In 1882, while running digestive experiments at the agricultural experiment station in Geneva, New York, Babcock noticed something strange – when placed under chemical analysis, the excrement of animals appeared to have the same composition as food. Could the station thus really create a healthful ration for livestock solely using chemical standards? At a meeting of agricultural chemists, Babcock reportedly told Atwater that "instead of feeding pigs on farm crops it would be cheaper to feed them soft coal," as Babcock's later colleague Elmer McCollum wrote. Babcock explained that "When such coal was analyzed by the food analysis procedures the results indicated that it was well balanced…by criteria of the chemical methods of food analysis bituminous coal had a high food value." McCollum noted that "Dr. Atwater did not like the analogy and was irritated by Babcock's treating a serious subject with levity."[404] Yet Babcock's observation was fundamental to the revolution that would take place in the science of nutrition. "Babcock—beginning with a slightly dirty and not at all dignified joke—" microbiologist and historian Paul De Kruif claimed in 1928, "was the pioneer who set a new kind of hunger fighter sniffing off on the trails to conquer these terrors."[405]

In the United States, the experiments that led to the identification of vitamins—shattering the scientific understanding of nutrition as simply proteins, fats, carbohydrates, water, minerals, and calories—did not originate in the tradition of nutrition of the pure laboratories of the Northeast, but in the nutrition science tradition of the agricultural land-grant colleges in the mid- to far West. Babcock left the experiment station in Geneva to work at the University of Wisconsin in 1888, where he proposed a small "single-grain" experiment to test the efficacy of chemical standards. Much like Harvey Wiley's "poison squad" experiment years later (Chapter 3), Babcock sought physiological evidence to demonstrate that nutritional knowledge based on chemical analysis was limited. In fact, Babcock, Wiley, Edwin Ladd, and Myer Jaffa shared a number of similar characteristics, including caution over modern food processing and preservatives, skepticism of the limits of current scientific knowledge, an explicit alliance with farmers, and work in using chemistry as a mediator between farmers and manufacturing, whether in grain grading (Ladd), measuring cream in milk (Babcock), analyzing poultry feeds (Jaffa), and analyzing fertilizers (Wiley and all others). Babcock's experiment was consistent with intellectual trends among chemists at the agricultural experiment stations from Indiana to California. De Kruif claimed that Babcock's research inquiry came from his belief that "next to nothing was known outside common

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404 Elmer Verner McCollum, *From Kansas Farm Boy to Scientist: The Autobiography of Elmer Verner McCollum* (Lawrence: University of Kansas Press, 1964), 116. Hart also recounted this joke in his obituary for Babcock: "[Babcock] delighted in telling Atwater, Armsby or Jordan - champions of the idea that the energy of a food measured its nutritive value —that if energy was the measure, then hot water or coal should be the most excellent of foods." EB Hart, "Stephen Moulton Babcock: (October 22, 1843–July 2, 1931)," *The Journal of Nutrition* 37, no. 1 (1949): 5. Coppin and High mention this observation by Babcock, it seems, to imply that the AOAC was not interesting in conducting nutrition experiments. Coppin and High, *The Politics of Purity*, 39. As noted in the dissertation introduction, C.S. Plumb also referenced this observation in 1891: Harris and Alvord, *Proceedings of the Fourth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations*, 91.

405 Paul De Kruif, *Hunger Fighters* (New York: Harcourt, Brace and Company, 1928), 270.

sense farmer knowledge" about what made a good ration, that it came from an understanding among all husbandmen that chemical analysis could not provide the full basis for adequate feeds.[406] In this chapter, I analyze this idea of "common sense farmer knowledge," and argue that in the United States, the pioneering experiments that led to the identification of vitamins and a paradigm shift in methodology arose from this agricultural tradition of nutrition science in the mid to far West.

In my focus on scientists working in the United States, I do not intend to distort the global nature of early research that led to the identification of vitamins, nor to make a priority claim for Babcock or other American scientists. Other researchers began to observe limits to chemical standards or to notice a connection between restrictive diets and certain diseases throughout the globe during this period. Yet researchers seem to have been unaware of much of the groundbreaking work taking place elsewhere, often because other research was published in languages that they did not know or in journals that they did not read, if it was published at all. Babcock, for example, never published his criticism of chemical analysis, and it was not until 1911 that experiments based on his initial research question (which he posed in 1882) were published as a Wisconsin Agricultural Station Research Bulletin #17 (and he was not listed as an author).[407] Moreover, many of the earliest understandings of what would become known as vitamins also came from the knowledge or observations of non-scientists. For example, Kanehiro Takaki, the chemist who first connected beriberi to diet in the 1880s in Japan, got this idea from servicemen who referred to their rations as "beriberi boxes."[408] Parents in coastal Northern Europe had given their children cod-liver oil to protect against rickets long before a concept of vitamin D, and, of course, sailors knew of the need for fresh food to protect against scurvy since the early modern period.[409]

However, I also do not wish to distort the innovative nature of the "single-grain experiment" – which is one of the earliest experiments that I have come across that was specifically designed to test the ability of chemical analysis to create rations, with a hypothesis that there were elements of food that were important to nutrition for which quantitative methods could not account. Other experimenters often began experiments that led to identifying micronutrients accidentally, while trying to keep experimental animals alive to study other diseases and inadvertently giving the animals rickets, beriberi, or another deficiency disease. The Wisconsin scientists designed their experiment because "common sense farmer knowledge" had shown that different farm rations produced different results, even if those rations appeared to be chemically equivalent. In this way,

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406 De Kruif, 277.

407 Though Babcock was not listed as an author, the authors acknowledge that the experiment was based on Babcock's ideas. It reads: "Some results secured in an early experiment at this station by Dr. S.M. Babcock were the real fore-runners of this larger investigation and to him the authors desire to express their great appreciation for the counsel and constant interest in the development of this work." EB Hart et al., *Physiological Effect on Growth and Reproduction of Rations Balanced from Restricted Sources*, Research Bulletin 17 (Madison: University of Wisconsin Agricultural Experiment Station, 1911), 203.

408 Kanehiro Takaki, "Three Lectures on the Preservation of Health Amongst the Personnel of the Japanese Navy and Army, Delivered at St. Thomas's Hospital, London, on May 7th 9th, and 11th, 1906: Lecture I, Delivered on May 7th," *The Lancet* 167, no. 4316 (May 19, 1906): 1369–74.

409 Ruth A. Guy, "The History of Cod Liver Oil as a Remedy," *American Journal of Diseases of Children* 26, no. 2 (August 1, 1923): 114. While there was a folk knowledge connecting diet to these diseases, this does not mean that people understood the concept of vitamins. For example, Joyce Chaplin argues that early modern circumnavigators understood scurvy as "earth sickness": The sailors believed that fresh food as well as soil and air on land contained a vital element that was missing at sea. Joyce E. Chaplin, "Earthsickness: Circumnavigation and the Terrestrial Human Body, 1520–1800," *Bulletin of the History of Medicine* 86, no. 4 (2012): 515–42.

the single-grain experiment was unique – the Wisconsin scientists were trying to prove that there were vital elements in food for which the current standards did not account.

I am not the first to identify early vitamin experiments in the United States with peculiarly agricultural motives. Some of the earliest historiography – such as that by De Kruif and by McCollum – emphasized the agricultural roots of these experiments, though other early historiography made no reference to the agricultural experiment stations. In the latter half of the twentieth century, historians debated the place of agricultural experiment stations in early vitamin research. Some argued that agricultural scientists were pioneers in vitamin research because of their unique concern for the economic feeding of animals, and because they were largely outside of the influence of medical paradigms like germ theory.[410] However, other scholarship challenged the narrative that placed agricultural experiment stations at the center of vitamin experiments. Naomi Aronson in particular pointed to the undue influence of Elmer McCollum on the historiography; McCollum was a scientist-historian who was trying to make his own priority claim and thus invested in emphasizing the agricultural roots of vitamin research (McCollum started his career at the University of Wisconsin and was a farm boy himself).[411] Aronson brought attention to the problem of "narratives of resistance" in the historiography of vitamin research. Influenced by scientists making priority claims and by their own disciplinary motives, historians have overexamined why early scientists resisted the concept of vitamins, Aronson argued, rather than examining the precursors that led to early vitamin research.

This chapter explores the precursors of vitamin research. I draw from elements of paradigm shifts outlined in Thomas Kuhn's 1962 classic. Kuhn explains how scientific paradigms are frameworks that work to solve the current problems in the science, and that paradigm shifts occur when these frameworks are no longer useful. Before industrial food processing, monocultures, and attempts to cheapen and rationalize diets of animals, prisoners, hospital patients, and students, the calorimetric paradigm—that measured food based on fats, proteins, carbohydrates and calories—worked. Vitamins were a natural part of food systems, and deficiency diseases were not common outside of sailors travelling long distances until the mid to late nineteenth century. I argue that it was only when vitamins were removed from the diets of seemingly well-fed people and animals that the calorimetric paradigm stopped working. The scientists trying to create cheap and wholesome feeds for animals, who were attuned to the way feeds influenced an animal's productivity, were some of the first to observe the limits of the calorimetric paradigm.[412]

Instead of asking "Why were vitamins discovered so late?", I ask "Why vitamins in this moment?"[413] The question of resistance, as Naomi Aronson has shown, implies a view of science

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410 Rosenberg, "On the Study of American Biology and Medicine"; Aaron J Ihde and Stanley L Becker, "Conflict of Concepts in Early Vitamin Studies," *Journal of the History of Biology*, 1971, 1–33; Howard A Schneider, "Rats, Fats, and History," *Perspectives in Biology and Medicine* 29, no. 3 (1986): 392–406.

411 Aronson, "The Discovery of Resistance."

412 More recent scholarship by scientist-historians also notes that the "single-grain experiment" was important for McCollum's later experiments in vitamins, including: Frances R. Frankenburg, *Vitamin Discoveries and Disasters: History, Science, and Controversies* (Santa Barbara: Praeger, 2009), 1–4; Carpenter, "A Short History of Nutritional Science: Part 2 (1885–1912)," 983.

413 For twenty-first century scholarship that examines the question of resistance to the vitamin theory, see: Robyn Braun, "Accessory Food Factors: Understanding the Catalytic Function," *Journal of the History of Biology* 44, no. 3 (2011): 483–504; Alexander R. Bay, *Beriberi in Modern Japan: The Making of a National Disease* (Rochester: University Rochester Press, 2012). An article that takes issue with the narratives of resistance, though from a different angle than this chapter, is: K. Codell Carter, "The Germ Theory, Beriberi, and the Deficiency Theory of Disease," *Medical History* 21, no. 2 (1977): 119–36.

as universal truths waiting to be uncovered. The simple answer to my research question is that vitamins were "discovered" in this moment, because it was not until this moment that vitamins were removed from people's diets on a large scale, or removed from the diet of animals in feeding experiments and on farms. Food processing, monocultures, and attempts to hyper rationalize diets in industrialized food systems created a need for an understanding of vitamins.

In this chapter I not only look at the larger societal changes that led to a need to understand vitamins, and to the study of diseases such as beriberi and pellagra, but also at the precursors to vitamins in the research of scientists. The priority claims about the discovery of vitamins have worked to silence the many scientists, particularly agricultural scientists at land-grant universities, who were consistently questioning the ability of chemical analysis to fully measure the healthfulness of food (as shown in the previous two chapters). By placing Babcock and the Single-Grain Experiment in this context, I show that Babcock was not alone in his challenging of the calorimetric, fat-protein-carbohydrate paradigm. He was a part of a tradition of skepticism in chemical standards forming among land-grant agricultural chemists.

The first part of the chapter focuses on the precursors to vitamin research. First, I examine how land-grant scientists expressed skepticism that the calorimetric paradigm captured the full value of foods – particularly the value of fruits and vegetables—in the USDA dietary surveys. Then, I look at the rise of beriberi in Japan and pellagra in the American South – two vitamin deficiency diseases that were reaching epidemic proportions during this period of early vitamin research. In the second part of the chapter, I examine the single-grain experiment and the question of priority in vitamin research. This part shows how the single-grain experiment was a part of the nutrition science tradition of land-grant agricultural scientists and was explicitly framed to challenge the calorimetric paradigm. Lastly, I examine how scientists, especially Elmer McCollum, distorted the nature of vitamin research in vying for the Nobel Prize – and how these distortions produced a lasting impact on the historiography.

I. Why Vitamins Now? The Problem of the "Why so Late?" Question

The Value of an Orange: Scientific Evaluations of Fruits and Vegetables before Vitamins

The scholarly focus on why scientists resisted the concept of vitamins –the "Why were vitamins discovered so late?" question—has directed attention away from the nutrition scientists who questioned the calorimetric paradigm before the discovery of vitamins, and particularly away from scientists who questioned the ability of the paradigm to evaluate the health benefits of fruits and vegetables. In fact, current scholarship in food history consistently argues that before scientists began identifying vitamins in the 1910s, American nutrition scientists thought fruits and vegetables were nutritionally worthless. "Because they preached in the era before the discovery of vitamins," writes historian Harvey Levenstein, "the New Nutritionists denigrated most fruits and vegetables, which emerged from labs as mostly water and carbohydrates."[414] Confined to their laboratories and their chemically reductionist view of food, chemists like Atwater argued that working-class consumers were better off spending their money on high-calorie foods that were dense in fats and proteins than on foods that were mostly water, the argument goes. E. Melanie Dupuis similarly points out that racism or ethnocentrism may have also contributed to these chemists' view that "meat, milk, and flour" were the basic components of a meal. "Vegetables, particularly greens," Dupuis argues, "were dietary elements associated with stigmatized

[414] Levenstein, *Revolution at the Table*, 57.

groups."[415] Dupuis repeats Levenstein's argument that before the "discovery of vitamins in the 1910s, home economists and nutrition scientists did not recognize any nutritional benefit of vegetables."[416] It was not until vitamins were isolated and made visible, this scholarship stresses, that nutrition scientists were able to change their view. "As late as 1911," historian Helen Zoe Veit writes, "the U.S. government nutritionist Charles Langworthy argued that fruits and vegetables were nutritionally void, and any faith in their health was superstitious […] To scientists, vitamins seemed improbable. They seemed folklorish."[417]

Yet this image of the narrow-minded laboratory scientist—unaware of the food values that folk knowledge systems had passed through generations—is a distortion of early nutrition research. As Chapter 1 argued, many scientists, particularly outside of the Northeast, in fact drew on folk knowledge systems in building nutrition standards. This included the study of "stigmatized groups" whose diets were largely composed of vegetables. Agricultural scientists also expressed skepticism about the ability of chemical analysis to fully measure food values, as discussed in the last chapter in the debates over the regulation of new processed foods. In both the dietary surveys and the pure food debates, agricultural scientists alluded to the idea that there was a value in foods that was unaccounted for in current nutritional knowledge.

University of California scientist Myer Jaffa provides a particularly clear case of a western, land-grant scientist who argued for the value of fresh produce before the discovery of vitamins. Jaffa's position as a publicly-funded scientist in California sparked, or perhaps necessitated, his interest in the health value of fruits and vegetables. During this period, the California landscape underwent what has been called the state's "horticultural revolution," as farmers across the state began producing fruits and vegetables ranging from asparagus in the Delta and oranges in Southern California to berries in the Santa Clara Valley and grapes in Fresno. "Perhaps no State in the Union is in better condition to exploit such problems," Jaffa wrote. "No month in the year finds the California market without fresh fruit of local production, and many people are to be found in the State who make this article an important part of their dietary."[418] Working at a state-funded agricultural institution, Jaffa was invested in examining the value of the foods produced by the state's farmers. The change in the California farming landscape towards mass production of fruits and vegetables led to a shift in scientific investigation, largely because Jaffa's research funding was tied to that agricultural landscape.

Jaffa's study of the Chinese diet—discussed in Chapter 1—was a part of a broader investigation of plant-based diets. Jaffa also conducted a study of the fruitarian diet–a vegan-like diet composed largely of raw fruits and nuts[419] —that the Office of Experiment Stations (OES) printed alongside the Chinese diet study in 1901. The OES framed the two studies as investigations into the value of produce. "Fruit is one of the very important agricultural products of this country, yet little is known of its true food value," wrote the Director of the Experiment Stations in the bulletin's introduction. "The studies here reported of persons living largely upon fruit are, therefore, of special interest in this connection, and, so far as known, are first of their kind."[420] Beginning the bulletin with a section on the "Nutritive Value of Fruit," Jaffa also identified this

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[415] DuPuis, *Dangerous Digestion*, 72.
[416] DuPuis, 92.
[417] Veit, *Modern Food, Moral Food*, 48. See also: Coveney, *Food, Morals, and Meaning*, 74.
[418] Jaffa, *Nutrition Investigations among Fruitarians and Chinese*, 7.
[419] In the study, the research subjects' diet was composed of: fresh fruit included apricots, peaches, plums, oranges, apples, bananas, grapes, berries, tomatoes, and figs; dried fruit included raisins, dates, and prunes; nuts included almonds, pine nuts, pine kernels, brazil nuts, walnuts, and peanuts (technically a legume); and also olive oil and honey.
[420] Jaffa, *Nutrition Investigations among Fruitarians and Chinese*, 3.

gap in nutritional knowledge. "Fruit is considered by the majority of persons as an accessory or supplementary food, eaten for its agreeable flavor or supposed hygienic or medicinal virtues, rather than as a staple article of diet," Jaffa stated.

> Perhaps for this reason very little scientific study has been given to fruit as compared with investigations which have been carried on in connection with other more common food materials. Chemical analysis has shown the comparative composition of fruits, but our knowledge of their dietetic value, digestibility, and comparative cost as sources of nutrients is far from being complete.[421]

Jaffa and the Office of Experiment Stations recognized the lack of scientific understanding of the value of fruits and vegetables.

On the surface, Jaffa could have used the data he collected to demonstrate the inferiority of the plant-based diet. Using the usual methods of chemical analysis, Jaffa found that the protein and energy intake of the fruitarian research subjects—two women and three children—were well below the dietary standards set by Atwater. Additionally, the women and children were small in stature, which could indicate malnourishment. Yet Jaffa's observations challenged the quantitative data. Despite the apparent lack of nutrients in the diet of a 13-year-old girl in the study, Jaffa noted that the girl "had all the appearances of a well-fed child in excellent health and spirits."[422] Though the six-year-old looked small for her age, "She impressed one as being a healthy child."[423] As the subjects were all related—one woman being the mother and the other the aunt—he rationalized that heredity, rather than nutrition, might explain the small stature of the family.[424] In a follow-up study of different fruitarian subjects, Jaffa continued to note that although the diets did not meet the Atwater nutritional standards, the subjects were in good health. A man who ate just sixty percent of the protein standard, Jaffa wrote, appeared in "excellent health and strength."[425] The results of both studies "showed that though the [fruitarian] diet had low protein and energy value, the subjects were apparently in excellent health and had been so during the five to eight years they had been living in this matter."[426]

Rather than using the standards and his chemical analysis to stigmatize or disparage the fruitarian diet, Jaffa used his observations to question the standards. "It would appear upon examining the recorded data and comparing the results with commonly accepted standards that all the subjects were decidedly undernourished, even making allowances for their light weight," Jaffa concluded.

> But when we consider that the two adults have lived upon this diet for 7 years, and think they are in better health and capable of more work than they ever were before, we hesitate to pronounce judgment. The three children, though below average in height and weight, had the appearance of health and strength. They ran and jumped

[421] Jaffa, 7.
[422] Jaffa, 14.
[423] Jaffa, 16.
[424] Jaffa, 15. Jaffa also noted that many children who ate a mixed diet—rather than a fruitarian diet—were considered "below average" in development, thus "it would be unfair to draw any conclusions until many more such investigations are made" (20).
[425] Myer E. Jaffa, *Further Investigations among Fruitarians at the California Agricultural Experiment Station. 1901-1902* (Washington DC: Government Printing Office, 1903), 21.
[426] Jaffa, 7.

> and played all day like ordinary healthy children, and were said to be unusually free from cold and other complaints common to childhood.[427]

Despite the chemical analysis indicating malnourishment, the children on this plant-based diet were, in some ways, unusually healthy. Jaffa thus "hesitate[d] to pronounce judgment" and called for further research.

Though Jaffa's observation connected the consumption of fruit with good health, it would be a mistake to say that Jaffa had an early understanding of vitamins. In fact, his main conclusion was simply that fruits, vegetables, and nuts had enough nutrients to be considered "true foods rather than food accessories."[428] Though he was hesitant to make "definite statements," he concluded that

> enough work has been done to show that [fruits and nuts] are quite thoroughly digested and have a much higher nutritive value than is popularly attributed to them. In view of this it is certainly an error to consider nuts merely as an accessory to an already heavy meal and to regard fruit merely as something of value for its pleasant flavor or for its hygienic or medicinal virtues.[429]

Jaffa consistently noted that the general public already viewed fruit as having "hygienic or medicinal virtues," and he used his studies to argue that they could provide more than that, that they could be the foundations of a healthful diet. Yet he never discussed what these "hygienic or medicinal virtues" were, or attempted to explore them. Though Jaffa did not explore the possible "hygienic or medicinal" virtues of fruits, in conducting his study and in using his observations alongside laboratory research, Jaffa challenged any scientific claim that fruits and vegetables were "nutritionally void."

Jaffa was not the only chemist to use observations from dietary surveys to question the contemporary scientific understanding of the value of fruits and vegetables. Isabel Bevier (the chemist who conducted the dietary study in Virginia in Chapter 1) also defended the inclusion of fruits and vegetables in diets in her studies. In 1898, she studied a family in Pittsburgh who ate a variety of fruits and vegetables, which gave "relish and variety to the food, but [did] not add especially to the amount of nutrients," she wrote. However, she added in a footnote:

> Such foods are undoubtedly of value for the acids and mineral salts which they contain. There are many theories which rest on such an assumption, and references to the value of fruit acids and salts are numerous, particularly in popular articles. The consensus of opinion of leading physiologists seem to be that few definite statements can be made on this subject, since the number of experiments bearing upon it is comparatively limited.[430]

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[427] Jaffa, 20.
[428] Jaffa, 3.
[429] Jaffa, 81.
[430] Bevier, *Nutrition Investigations in Pittsburgh, Pa., 1894-1896*, 16. Throughout the remainder of the study, she continued to defend the use of fruits and vegetables in the diet. "Oranges contain little protein and are low in fuel value," she wrote, for example, "but are undoubtedly valuable of the sake of variety and perhaps for some tonic effect which they may exert" (17).

Rather than dismissing folk understandings of the value of fruits and vegetables, Bevier pointed to the limited scientific work on the subject, and the importance of variety in the diet. In a study of women at Lake Erie College in Ohio in 1901, Bevier and a colleague again defended the value of fresh produce in the diet. In the study, they noted that the students expressed a "strong preference" that was "equivalent to demand" for fresh fruit with their breakfast.[431] Though fresh fruit took a good portion of the budget, Bevier and her colleague supported its use, describing how the fruit was valuable because it was attractive, sweet, satisfying, and stimulated the appetite. "While the fact was appreciated that this meant a considerable outlay of money with an apparently small return in nutritive value," she and her colleague argued, "it was felt that the real value of fruit in a diet can not be fully expressed in such terms."[432] In their studies, both Bevier and Jaffa argued that quantitative analysis missed other values in fresh produce.

Although Atwater has been portrayed as the main advocate of the idea that fruits and vegetables were nutritionally worthless, even he hinted at the value of these products. In his dietary study in Chicago, Atwater wrote that "green vegetables, such as cabbage, onions, lettuce, etc., and the fruits, furnished but little actual nutriment for the money expended," but later added that "A certain amount of such green vegetables is desirable and perhaps necessary."[433] Though "[f]ruits add comparatively little to the food value of a diet," he explained that "they are undoubtedly valuable for other reasons."[434] He even stated that "[v]egetable foods are apparently essential to a well regulated diet," though he also stated that variety in the vegetables eaten had no known advantage.[435] Atwater was not as assertive in his negative evaluation of fruits and vegetables as the current scholarship suggests. He certainly questioned the food value of produce, but at the same time admitted that fruits and vegetables may have some essential purpose in the diet.

Even that infamous bulletin by Charles Langworthy, published just before Casimir Funk published his groundbreaking vitamin paper, in which Langworthy supposedly declared fruits and vegetables to be void of nutrients, seems to have been distorted in scholarship. The bulletin, in fact, had the opposite goal: Langworthy sought to explain why vegetables, though seeming to lack in nutrients, were actually a valuable component of the diet. "Many of the succulent vegetables, in spite of their solid appearance, contain a larger proportion of water than does milk," he wrote.

> Their value in the diet, therefore, and they have a decided value, lies not in any large quantity of nutrients, but in small quantities of special materials which they provide and the bulk which they give the diet, and also in their appetizing qualities, their flavor and appearance, and the variety which they make possible.[436]

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[431] Bevier and Sprague, "Dietary Study at Lake Erie College, Painesville, Ohio."
[432] Bevier and Sprague, 28. It is worth noting that in this study, Bevier echoed Jaffa's questioning of protein standards: "The authors were confident that the supply of protein provided by the diet evidently desired by the students would be somewhat lower than the amount required by the commonly accepted dietary standard. Yet the students were in excellent health and the diet apparently satisfied their needs…there seemed no real need for more protein, judging by the comments of the students on the diet or as evidenced by any lack of tone in health" (29).
[433] Atwater et al., *Dietary Studies in Chicago in 1895 and 1896*, 26.
[434] Atwater et al., 72.
[435] Atwater et al., 72.
[436] Charles Ford Langworthy, "Green Vegetables and Their Uses in the Diet," in *Yearbook of the Department of Agriculture. 1911.* (Washington DC: Government Printing Office, 1912), 447.

Though green vegetables contained smaller amounts of protein, fat, and carbohydrates than the amounts in "staple foods such as bread, meat, and cheese," Langworthy emphasized that they were valuable for three primary reasons: mineral matter, digestion, and variety.[437]

His discussion of mineral matter is notable in considering the precursors to vitamin research. Langworthy described how fruits and vegetables contained high amounts of mineral matter, such as potassium and iron. "[I]f for any reason the body lacks these foods for a long time, disease may result," he explained. "It is well known that scurvy, which was so common on old sailing vessels, where the diet was usually made up very largely of bread and salt meats, was prevented or relieved by the addition of an abundance of green vegetables, potatoes, or other fresh foods to the diet."[438] Fresh foods – especially citrus and green vegetables—had long been associated with curing or preventing scurvy, but many scientists thought that the foods served as a tonic against an illness, especially after the advent of germ theory. Langworthy's hypothesis is noteworthy because he connected scurvy to the lack of an element in the foods, though he thought that element was a mineral (today, we know that element is vitamin C). Langworthy described substances in fruits and vegetables that he believed were necessary to maintain the health of the body, but he thought these substances were mineral matter. He emphasized that spinach was "a valuable article of diet" for the high amounts of iron it contained, and that the body needed mineral matter to properly absorb nutrients.[439] Though lacking in fat, protein, and carbohydrates, Langworthy argued that fruits and vegetables provided vital components of the diet.

To a present-day reader, Langworthy's argument on mineral matter might appear to be the most important argument for the nutritional value of green vegetables. But Langworthy actually claimed that fresh produce was most valuable to health because it added variety and flavor to the diet. Langworthy stated that green vegetables "do not add greatly to the total nutrients and fuel value, except in relation to the cost, but they do increase the wholesomeness of the diet," not only through mineral matter and aid to digestion, but also "by making the diet more varied and attractive. The last is probably the most important point in the ordinary mixed diet of persons in normal health living under the usual conditions."[440] For an ordinary person—rather than a sailor at sea—this variety and palatability was the most important reason to include fruits and vegetables in the diet.

It appears that palatability was a widely held value among nutrition scientists, particularly because it was linked with digestion. Bevier consistently defended the value of palatability, or pleasure in eating in her studies. Though spices and condiments like mustard and nutmeg "neither build tissue nor yield energy," she explained, "they serve to make the food more palatable and may be of some aid to digestion by causing a more profuse secretion of the digestive juices and in other ways."[441] Butter was valuable "not only for the fat it contains, but also for the relish it gives the food and the sake of variety of food materials."[442] Bevier was explicit that she did not think families should attempt to cut all low-nutrient foods from their diet; that foods had value outside of nutritional analysis. "The individual preference and the income of a family must govern the amount in which many of the food materials furnishing little actual nutritive material should be used," she explained. "It is not the purpose of this and similar investigations to limit the choice in

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[437] Langworthy, 447.
[438] Langworthy, 448.
[439] Langworthy, 448.
[440] Fruits and vegetables added variety to the diet without high costs in domestic labor and fuel, he explained, because many of them do not require much preparation and cooking.
[441] Bevier, *Nutrition Investigations in Pittsburgh, Pa., 1894-1896*, 42.
[442] Bevier, 22.

this matter, but rather to furnish the data for comparison, leaving deductions to be drawn by those interested. The pleasure derived from a varied dietary may more than offset the difference in cost, within limits, if absolute economy need not be practiced."[443]

Myer Jaffa wrote that it was necessary to consider palatability in studying restrictive diets. In one of his studies, a diet of a single fruit "proved so unpalatable that it was deemed best to supply small amounts of olive oil, tomatoes, or other materials in addition, in a number of cases these articles being taken simply as relishes. When this was done the diet was regarded as palatable."[444] He wrote of one subject: "The subject noticed that the diet used was monotonous, and that he did not look forward to mealtime with any degree of pleasurable anticipation."[445] He wrote that the subject would have eaten more if he had "been able to eat the food with more relish."[446] Throughout his study of the fruitarian and the Chinese diet, he also consistently noted when the subjects ate their meals with "relish." For example: "The subject stated that, having made the comparison, he preferred the fruitarian breakfast to any other. In general, he relished the diet consisting almost exclusively of fruits and nuts."[447] As we will see in the next chapter, taste was also an important component of the work of nutrition scientists for the Food Administration during World War I. Palatability was not outside of understandings of nutritional wholesomeness, as it was associated with healthful digestion and nutrient absorption, appetite, and pleasure or "relish."

While Langworthy argued that green vegetables were a valuable component of American diets, he dismissed beliefs in medicinal virtues of specific vegetables, which may be why scholars like Veit argue that Langworthy viewed vitamins as "folklorish." He wrote that "popular statements are numerous" that "some particular kind [of vegetable] is very nutritious or is possessed of some special virtues; yet there is very little accurate evidence on which to base such assertions, and, generally speaking, they can be traced to beliefs of an earlier time."[448] Older beliefs may have linked specific foods to specific medicinal properties, but this knowledge, he argued, was now outdated. However, Langworthy was not contesting the idea that vegetables held special health values; rather, he contested the idea that any specific vegetable had a specific medicinal property. "[W]hen due allowance is made for all such facts," he wrote, "it is still true that for most healthy persons the benefits which come from eating green vegetables in abundance are due to their general qualities and not to specific medicinal virtues which some of them may possibly possess in small degree."[449] While using a specific vegetable as a specific tonic seemed folklorish to Langworthy, he did not write that the belief in the overall health value of vegetables was folklorish. He in fact used the bulletin to defend these health values.

So why have historians written that early American nutrition scientists saw fruits and vegetables as "nutritionally void," when many scientists justified the importance of including fruits and vegetables in the diet—despite the fact that fresh produce appeared to be mostly water—and called for more research? It could be that scholars are using a present-day idea of how to scientifically measure "wholesomeness," and so they overlook statements on digestion, minerals, and—perhaps the least scientific by today's standards—palatability as unscientific and

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443 Bevier, 18.
444 Jaffa, *Further Investigations among Fruitarians*, 35.
445 Jaffa, 50.
446 Jaffa, 50.
447 Jaffa, 27.
448 Langworthy, "Green Vegetables and Their Uses in the Diet," 449.
449 Langworthy, 449. Again emphasizing the value of palatability, he thought that the "tonic" impact of green vegetables may have been "really ascribable to the fact that they were a very welcome addition to the winter fare and made the food more appetizing" (449).

unimportant. Or it could be that the narrative of a narrow-minded laboratory scientist—so reductionist that he or she misses something that had been passed through folk knowledge systems for generations—is particularly attractive for its progressive ("we are smarter than those in the past"), parabolic ("beware of laboratory reductionism!"), or anti-elitist ("the professionals got it wrong while folk knowledge was right") qualities. It could be because many of the chemists defending the health value of fruits and vegetables were applied scientists, rather than pure scientists; who worked for the USDA and land-grant colleges, rather than Harvard or Johns Hopkins. It could also be that this distorted narrative has endured from earlier scientist-historians who wrote the first histories of nutrition science while making their own priority claims about vitamin research, and sought to inflate the importance, innovation, or genius of their own findings (which I will discuss at the end of this chapter). It might be that scholars and historians have relied on this earlier scholarship, leading to an enduring distorted narrative.

Whatever the reason, by focusing on the idea that before the discovery of vitamins, chemists thought that fruits and vegetables were "nutritionally void," scholars have missed some key components of this early research on fresh produce. They miss how important palatability was to understandings of nutrition; that it was believed to be an essential component of nutrient absorption, food conservation, and overall pleasure. They also miss historical factors that help to explain why pioneering vitamin research began during this period. Why did Langworthy write this bulletin on green vegetables? Why did Jaffa study fruitarians? And why did Bevier observe students eating oranges with their breakfast in Ohio? Because of the rising mass production and new mass market for fresh fruits and vegetables. The oranges in Bevier's cafeteria came from the agricultural developments that spurred Jaffa's research in the values of fruit and vegetables. Langworthy began his bulletin by noting that "[o]ne of the marked differences between the daily fare to-day and that of 50 years ago consists in the increased supply of green and succulent vegetables, a class of food used for their refreshing and palatable qualities more than for their total nutritive value." He attributed this change in daily fare to "[n]ew and improved varieties, better methods of cultivation, improvements in transportation and storage, the great development of market gardening under glass, and the development of the canning and preserving industry," which "have made succulent vegetables common throughout the year and available in one form or another."[450] Though fruits and vegetables may not be valuable in providing calories of fat, protein, carbohydrates, Langworthy depicted this increased consumption across all classes as a boon to public health. "It would seem that their use is more common in this country in families of all circumstances than is the case in some other countries," Langworthy wrote, "and this is surely an advantage."[451]

As the growing market for and production of fresh produce increased the interest of USDA and land-grant scientists in their value, there was also a growing recognition among these scientists that the current scientific knowledge was limited. These scientists recognized that staples – rather than so-called "accessories" such as fresh produce—had been the focus of most nutrition research. At the same time, their observations in the dietary surveys challenged the contemporary dietary standards, causing them to "hesitat[e] to pronounce judgment" on seemingly deficient diets that appeared healthful and to recognize that there were values that could "not be fully expressed" in

[450] Langworthy, 439.
[451] Langworthy, 449. Jaffa's research also describes how fruits and nuts were sold at affordable prices. Fruits and nuts were transforming from luxury items into everyday commodities during this period.

the current terms of nutrition science.[452] These scientists brought into question the paradigm of quantitatively measuring the nutritional value of foods in terms of fats, proteins, carbohydrates, and calories – the calorimetric paradigm. This skepticism was also present in the pure food debates in Chapter 2, and set the foundation for Babcock's famous experiment. But before turning to that experiment, it is worth briefly examining another revolution in the food system—aside from the mass production and mass marketing of fresh produce—that spurred early vitamin research.

The Rise of Vitamin Deficiency Diseases: Beriberi and Pellagra

Scholars who have argued that early nutrition scientists "denigrated most fruits and vegetables" have highlighted the possible health consequences of following their guidelines. "[I]f America turned *en masse* to follow their advice," writes Levenstein, "rickets, beri-beri, scurvy, and other vitamin-deficiency diseases may have reached epidemic proportions."[453] The previous section has shown that this "denigration" of fruits and vegetables among scientists has been overstated. Additionally, Levenstein's statement distorts the fact that there *were* two deficiency diseases reaching epidemic levels in this period: beriberi in Japan and pellagra in the southern United States. Yet the rise of these two diseases to epidemic proportions had little to do with the advice of scientists.

Deficiency diseases were not unique to this era, as they had appeared in times of siege or famine and in prisons or on ships for centuries. Descriptions of beriberi—a disease caused by a deficiency in vitamin B-1 (or thiamin)—appeared in Chinese medical writings as early as 600 AD (according to some sources, perhaps even earlier), but it was not until the nineteenth century that it became a problem that attracted sustained attention from medical researchers.[454] Pellagra—a disease caused by a deficiency in vitamin B-3 (or niacin)—had long been recorded in Europe and associated with corn consumption. Yet, it was not diagnosed in the United States until the twentieth century, in 1907.[455] And scurvy—a disease caused by a deficiency in Vitamin C—had been associated with long voyages at sea for centuries, and the prevention of—or "cure" for – scurvy was connected to citrus and green vegetables, Kenneth Carpenter claims, "for some 200 y" before James Lind's famed trial in 1746.[456] It is difficult to assess how widespread these three deficiency diseases were among the landed population before the nineteenth century. The diseases may have been uncommon, but they may have also simply gone unnoticed or undiagnosed. Before the nineteenth century, deficiency diseases outside of special circumstances (such as voyages or prisons) likely would have accompanied other poverty-related conditions, including general malnourishment and hygienic issues. It would be unsurprising if another health issue arose alongside or before a deficiency disease occurred. After all, deficiency diseases result from a dietary extreme – it takes a sustained monotonous diet for a long period of time for the disease to manifest in an otherwise healthy body.

The nineteenth century brought changes in food systems globally that allowed some deficiency diseases to become widespread, even among populations that appeared to be well-fed.

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[452] Jaffa, *Further Investigations among Fruitarians*, 20; Bevier and Sprague, "Dietary Study at Lake Erie College, Painesville, Ohio," 28.
[453] Levenstein, *Revolution at the Table*, 57.
[454] Kenneth J. Carpenter, *Beriberi, White Rice, and Vitamin B: A Disease, a Cause, and a Cure* (Berkeley: University of California Press, 2000), 2, 9, 26; Carter, "The Germ Theory, Beriberi, and the Deficiency Theory of Disease," 124.
[455] Alfred J. Bollet, "Politics and Pellagra: The Epidemic of Pellagra in the US in the Early Twentieth Century.," *The Yale Journal of Biology and Medicine* 65, no. 3 (1992): 211–12.
[456] Carpenter, "A Short History of Nutritional Science: Part 1 (1785–1885)," 643.

Examining the rise of beriberi in Japan and pellagra in the American South reveals similar shifts in food systems that permitted the diseases to reach epidemic proportions. The fact that pioneering vitamin research took place alongside the rise of beriberi and even *before* the rise of pellagra reveals how the question, "Why were vitamins discovered so late?" is ahistorical. It was not until vitamins were removed from the diets of a large population of seemingly well-fed people that a paradigm shift in nutrition science was needed. Briefly examining beriberi and pellagra can help address the "Why now?" question, both for the rise of these diseases and the breakthroughs in nutrition science.

Just as European sailors and navy doctors linked fresh food with preventing scurvy, a doctor in the Japanese Navy conducted one of the first experiments to link beriberi—called kakke in Japan—to diet. Kanehiro Takaki became naval doctor in 1872, at a time when the Japanese Navy was experiencing an unprecedented outbreak of beriberi.[457] At the time, medical researchers had various theories on what caused the disease, from infection to miasma. Takaki first hypothesized that the disease may be connected to diet not by reading medical texts (which often portrayed it as some sort of infection), but from a comment from his father, who served as a guard at the Imperial Palace.[458] As Takaki told it, in 1862, his father described the disease to him and explained that the guards "attributed the cause to food and called a provision box the 'beri-beri box.'"[459] With this initial idea in mind, in 1882, Takaki began to collect records on the location, season, rank, housing, and other details of patients suffering from beriberi. He found that the disease was rare among officers and "men having a sufficient supply of food," and rare on voyages with "long stoppages at ports" where they might be "supplied with fresh articles of food."[460] He noted that that disease appeared most frequently in spring to summer, that it impacted people in both small towns and urban centers, and that the upper classes rarely suffered from the disease. Because class and rank seemed to shape the outbreak of disease, Takaki paid close attention to the "hygienic conditions" of patients, including the details of their diets. Here he found his answer – there was a distinct difference in the diet of those who suffered from beriberi and those who did not experience the disease. The "true cause of beri-beri," Takaki explained in a lecture in 1906, "lies in the wrong method of diet."[461]

Yet Takaki's observations did not lead him to hypothesize that a vital micronutrient might be missing from the diets of those suffering from beriberi, nor did it cause him to question the current nutritional paradigm based on fats, proteins, and carbohydrates. Instead, Takaki concluded the diet of beriberi patients "contained too much carbohydrates," and that this imbalance of

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[457] A full one third of servicemen had the condition. Takaki had studied medicine in London between 1875 and 1882, and described the experience of returning to Japan to see the dire conditions: "Such conditions used to strike my heart cold whenever I came to think of the future of our Empire," he explained, "because, if such a state of health went on without discovering the cause and treatment of beriberi our navy would be of no use in time of need." Carpenter, *Beriberi, White Rice, and Vitamin B*, 10; Takaki, "Three Lectures [...]: Lecture I," 1370.

[458] Traditional Japanese doctors had thought beriberi was the result of an "edema of the spinal cord," and had attempted to treat it through acupuncture and blistering to no avail. Meanwhile, Western physicians had thought that the disease was caused by miasma which rose up from the soil, and that the disease was a particular problem in Japan because people sat on the floor. Takaki ruled this out because soil and miasma would have little impact on ships. Carpenter, *Beriberi, White Rice, and Vitamin B*, 6–10. For an examination of the various medical understandings of beriberi in Japan, see: Bay, *Beriberi in Modern Japan*.

[459] Takaki, "Three Lectures [...]: Lecture I," 1370.

[460] Kanehiro Takaki, "Three Lectures on the Preservation of Health Amongst the Personnel of the Japanese Navy and Army, Delivered at St. Thomas's Hospital, London, on May 7th 9th, and 11th, 1906: Lecture II, Delivered on May 9th," *The Lancet* 167, no. 4317 (May 26, 1906): 1451–52.

[461] Takaki, 1452.

carbohydrates to protein in the diet had a toxic effect.[462] After experimenting with the diets of hospital patients with significant results, and after a particularly severe outbreak of beriberi in the navy, the government gave him permission to implement a new diet on one ship as a trial. Adding meat, milk, and vegetables to the rations produced remarkable outcomes – the ship had no deaths from beriberi and only fourteen cases of the disease (among men who refused to eat the meat and milk rations). The Japanese Navy changed their rations in response, and by 1887, there were only three cases of beriberi reported, compared to over a thousand cases per year in the period before Takaki began his studies. Takaki further observed that when prisoners were given barley instead of rice (due to shortages or prices), the rates of beriberi decreased. Attributing this special property of barley to its higher protein content, he ordered that the navy substitute barley for half of the rice rations.[463] In a similar way to Lind's clinical trial on scurvy, Takaki used ships and prisons as laboratories to test his theory that beriberi was caused by an unbalanced diet.[464] But unlike Lind, Takaki's study seemed to demonstrate the ill consequences of a diet composed of too many carbohydrates and too little protein, rather than point to the special properties of certain foods.[465] In other words, the calorimetric paradigm *worked* to solve the problem of beriberi for Takaki (because barley and meat also contain vitamin B1).

Rather than asking why it took another thirty years before vitamins were identified, it is worth asking the question of why Takaki undertook this study of beriberi in this moment. Part of the answer lies in the increased development of the Japanese Navy and the government responsibility for the health and rations of servicemen.[466] But beriberi in the Japanese Navy was not solely attributed to inadequate rationing; it was also attributed to changing food preferences. "By last year's experience we have found that most of the men dislike meat as well as bread, and we do not know what we shall do next," Takaki explained in his 1906 lecture. "But if we leave the matter to their own choice we shall certainly have a great many cases of beri-beri as has hitherto been the case, especially as more than 1000 new men have been enlisted this year." The taste preferences of the servicemen, Takaki emphasized, were partially the cause for the outbreak of the disease, and this taste preference was new. "We believe that the majority of the men in our navy have been used to take barley food from their childhood," Takaki continued, "so that in reality they can eat it, although they show their dissatisfaction at it after becoming accustomed to the rice given to them, since they entered the navy."[467] As the navy sent bags of white rice to their recruits, white rice increasingly became the preferred center of the servicemen's diet.

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462 Takaki, "Three Lectures [...]: Lecture I," 1371.

463 Carpenter, *Beriberi, White Rice, and Vitamin B*, 12.

464 In the case of scurvy, food preservation techniques that allowed voyagers to travel long distances without needing to stop for provisions also destroyed the vitamin C content of foods, which is why scurvy went hand-in-hand with early voyages. In a similar way, beriberi in the Japanese navy was connected to a food processing technique that allowed rice to have a longer shelf life. Alexander Bay also discusses how Takaki "blurred the distinction" between the laboratory and the field in his ship experiments. Bay, *Beriberi in Modern Japan*, 50.

465 Takaki had two theories on why this imbalance between protein and carbohydrates might result in disease. One was the idea of autointoxication – that an excess of carbohydrates might poison the body. Another hypothesis was that it might come from the inability of muscles to repair themselves with too little protein in the diet. Takaki, "Three Lectures [...]: Lecture I," 1371.

466 Takaki partially blamed the outbreak on the government planning rations "according to the monetary system without any regard to quality or quantity." Takaki, "Three Lectures [...]: Lecture II," 1454. Alexander Bay's recent work on beriberi in Japan defines beriberi as a "disease of empire," and Bay links the rise of beriberi to an "imperial and national culture" and militarization, including the use of white rice in army rations. Bay is interested in the production of medical knowledge and why certain scientists supported "the contagionist approach" (8) and resisted the vitamin theory of disease. Bay, *Beriberi in Modern Japan*.

467 Takaki, "Three Lectures [...]: Lecture II," 1452.

Much of the reason for this new preference was also due to changes brought by industrialization of food processing and agriculture. Before the mid-nineteenth century, rice was most often hand-milled, which left some of the rice's silver skins—which we now know contain vital micronutrients, including thiamin—in place. The development of steam-powered processing of rice created an extremely efficient method to fully remove the silver skins—and thus the vitamins—from the rice. This steam-processed white rice had a longer shelf life and could travel greater distances, helping to feed a growing urban population. The centering of the diet on white rice also spread to the rural population in Japan. Takaki connected this change in diet to land reform and agricultural change. "The appearance of beriberi all over the country and its tendency to increase seemed to have its origin in the reformed land-tax of the sixth year of Meiji (1873)," he wrote.

> Since that time the habit of eating rice as the chief food settled upon the remote districts; and besides, owing to the general tendency throughout the country to raise mulberry leaves, the production of rice and other cereals markedly decreased. In consequence, the vegetable aluminates contained in food necessary for bodily nutrition decreased, while, on the contrary, the amount of carbohydrates comparatively increased, thus causing the increase of the disease.[468]

Scholar Steven J. Ericson has analyzed how in the late nineteenth century, Japan shifted from a net-exporter to net-importer of rice, as per capita consumption of rice increased. This was partially due to urbanization, but Ericson also notes that rice consumption increased in rural areas, where "more and more Japanese eschewed 'lesser' grains in favor of the higher-status, urban, white rice diet."[469] Ericson argues that the most important factor that caused an increase in rice consumption in rural areas may have been that the "real disposable income per farmer increased," due to a change in land taxes and increased grain prices .[470] The decline of subsistence agriculture and the encouragement of commodity-based agriculture, combined with the industrialized processing of rice and increasing access to and reliance on purchasing white rice, created a new diet that gave rise to beriberi. The fact that the disease was breaking out not only in prisons and on ships but among civilians and farmers reflects how diets among the general population were changing with the industrialization of the food system. Industrialized food processing could remove vital elements from the diet. The growing appearance of beriberi in Japan, and subsequent interest of scientists like Takaki in understanding the disease, was a result of the industrializing food system.

As beriberi and white rice spread throughout Japan into the early twentieth century, medical researchers in the United States began to notice another peculiar and deadly disease on the rise in the American South. In 1909, public health officials printed a bulletin on the "Prevalence of Pellagra in the United States," tracing its growth from a few reported cases in asylums in Alabama and South Carolina in 1907 to an estimated 1500 cases in the Southern States

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468 Takaki, 1454.

469 Steven J. Ericson, "Japonica, Indica: Rice and Foreign Trade in Meiji Japan," *The Journal of Japanese Studies*, Japonica, Indica, 2015, 322.

470 Ericson, 340. Ericson also describes how the increase in white rice consumption was also the result of government rations distributed under the 1873 Conscription Act. He points to the way that urbanization impacted rural consumption patterns, writing that rice consumption increased "not only because many rural folk moved to urban areas but also because an urban-style diet gradually spread to the countryside as factors like conscription and newspaper coverage exposed rural inhabitants to urban lifestyles" (340).

at the time of publishing.[471] Just three years later, the disease rate had risen dramatically – to 15,870 cases and 6,205 deaths (seeming to have a death rate of 39.1 percent!) reported in the southern United States.[472] In the first half of the twentieth century, there would be over 3 million cases of pellagra and 100,000 deaths caused by the disease (at its height, there were 250,000 cases and 7,000 deaths in one year).[473]

Unlike beriberi, pellagra reached its epidemic proportions after Casimir Funk proposed the vitamin theory in his 1912 paper. While scientists studying beriberi connected the disease to a dietary deficiency before the vitamin concept was fully defined, researchers studying pellagra debated the cause of the disease well into the 1920s, after the vitamin concept had been firmly established in nutrition science. The pellagra epidemic, in fact, was still rampant in the late 1920s, when chemists had even developed techniques in fortifying foods with some vitamins by this time (see Chapter 5). This lengthy debate over the cause of pellagra was not due to researchers being unaware of the possibility that pellagra could be linked to a vitamin deficiency; American scientists publicly theorized that pellagra was deficiency disease similar to beriberi as early as 1912. Even in 1908, at the first conference on pellagra held in the United States, Dr. James Wood Babcock (the conference organizer and superintendent of a hospital in South Carolina) drew on the established connection between pellagra and corn consumption to argue that "As a rule, the patient [suffering from pellagra] should not be allowed any food derived from Indian corn…A generous dietary should be given, including fresh meats and vegetables."[474] Many researchers recognized the correlation between monotonous diets based on corn and high rates of pellagra, but researchers often hypothesized that the disease may be caused by spoiled corn, or that this was simply a correlation and the disease was caused by a germ.

In 1912, with introduction of the vitamin concept, some prominent scientists began to argue pellagra was a deficiency disease. Funk himself listed pellagra among vitamin deficiency diseases in his famed 1912 paper that first used the term "vitamine." He noted the similarities between pellagra and beriberi, as both diseases were associated with a monotonous, starchy diet; but while the scientific consensus by that time was that beriberi was caused by a nutrient deficiency, Funk lamented that beliefs that pellagra was caused by infection or intoxication (from spoiled corn) were firm.[475] At the meeting of the National Association for the Study of Pellagra in 1912, other scientists read papers supporting Funk's argument. Surgeon General Rupert Blue stated that the theory was promising, that pellagra was a disease "in the same category of scurvy and beriberi. It is only in the case of an exclusive of one-sided diet of corn: and, if the corn is spoiled, it is all the more deficient in nutritive values."[476] British medical research and physician Fleming Sandwith followed with a paper citing Frederick Gowland Hopkins' research on "accessory food factors" with young mice and Funk's work on beriberi. "Is pellagra, too, a deficiency disease, waiting for

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[471] Claude H. Lavinder, CF Williams, and James W. Babcock, "The Prevalence of Pellagra in the United States. A Statistical and Geographical Note, with Bibliography," *Public Health Reports* 24, no. 25 (1909): 850; Charles S. Bryan and Shane R. Mull, "Pellagra Pre-Goldberger: Rupert Blue, Fleming Sandwith, and The 'Vitamine Hypothesis,'" *Transactions of the American Clinical and Climatological Association* 126 (2015): 23.
[472] Lavinder, Williams, and Babcock, "The Prevalence of Pellagra in the United States. A Statistical and Geographical Note, with Bibliography," 2077.
[473] Bollet, "Politics and Pellagra."
[474] Quoted in: Bryan and Mull, "Pellagra Pre-Goldberger," 28.
[475] Casimir Funk, "The Etiology of Deficiency Diseases. The Etiology of Deficiency Diseases. Beri-Beri, Polyneuritis in Birds, Epidemic Dropsy, Scurvy, Experimental Scurvy in Animals, Infantile Scurvy, Ship Beri-Beri, Pellagra.," *The Journal of State Medicine* 20, no. 6 (1912): 358–63.
[476] Quoted in: Bryan and Mull, "Pellagra Pre-Goldberger," 33–35.

a vitamin to be discovered?" he asked.[477] Despite this early connection between pellagra and vitamin deficiency, scientists continued to debate the causes of the disease as the epidemic raged on for the next fifteen years.

The rise of pellagra in the early twentieth century thus offers a rich case study for examining resistance to scientific theories. This story of resistance often centers on Joseph Goldberger, who was appointed by US Public Health Service to research pellagra in the South in 1914. Goldberger concluded that pellagra was a deficiency disease within four months of research, demonstrating that solely giving patients a more varied diet cured the disease.[478] Yet, he would spend the next decade proving that it was *not* an infectious disease. He went to such extremes that he used the scabs, feces, and urine of those suffering from pellagra to try to transmit the disease to "willing subjects (including himself, his wife, and his close associates)" to prove that the disease was not infectious.[479] Historians have examined why, even with seemingly definitive proof, many scientists continued to argue that the disease was infectious, including excitement over the new germ theory of disease and evidence that seemed to support the idea that pellagra was caused poor hygiene or spread by insects.[480] Historians have also outlined the social, cultural, and political factors that influenced resistance to the deficiency theory of pellagra, such as the rejection of the image of Southern poverty implied in the deficiency theory and how researchers missed social indicators that linked the disease to diet.[481] Perhaps the most convincing reason that scientists may have rejected the deficiency theory was because its proposed solution was politically and socially unappealing: improve the diet of the poor. Goldberger himself argued that to combat the pellagra epidemic, they would need to "improve economic conditions, increase wages, reduce unemployment" and "make the other class of foods"—as in, foods other than starchy carbohydrates—"cheap and accessible."[482] These structural solutions to improve the conditions of the impoverished in the South were "beyond the physician's control" and seemed impossible to many.[483]

This brief summary of the scholarship on pellagra research should demonstrate why this disease offers an illuminating case study for examining resistance in the history of medical science. But the focus on resistance –like the question of "why so late?" for the vitamin theory generally—does not address why pellagra reached epidemic proportions during this particular period. Like beriberi, the rise of pellagra was the result of dietary changes in the American South in the early twentieth century– changes connected to food processing and an increasingly industrialized agricultural landscape. The monotonous diet of Southerners that became associated with the disease—called the "three M diet" (meat (pork fat), meal (corn), and molasses)—had a longer history in the South, but before the twentieth century, it seems as though poor and enslaved Southerners may have only experienced the initial stages of the disease in late winter/early spring

[477] Quoted in: Bryan and Mull, 34.
[478] Bryan and Mull, 36.
[479] Stephen J Mooney, Justin Knox, and Alfredo Morabia, "The Thompson-McFadden Commission and Joseph Goldberger: Contrasting 2 Historical Investigations of Pellagra in Cotton Mill Villages in South Carolina," *American Journal of Epidemiology* 180, no. 3 (2014): 237.
[480] Bryan and Mull, "Pellagra Pre-Goldberger"; Mooney, Knox, and Morabia, "The Thompson-McFadden Commission and Joseph Goldberger: Contrasting 2 Historical Investigations of Pellagra in Cotton Mill Villages in South Carolina"; Elizabeth W. Etheridge, *The Butterfly Caste: A Social History of Pellagra in the South* (Westport, CT: Greenwood Pub. Co., 1972).
[481] Etheridge, *The Butterfly Caste*, viii, 13; Bollet, "Politics and Pellagra."
[482] Quoted in Bryan and Mull, "Pellagra Pre-Goldberger," 39..
[483] Etheridge, *The Butterfly Caste*, viii. The scientific consensus that a vitamin deficiency caused the disease came after Goldberger discovered a cheap supplement that prevented pellagra: brewer's yeast. I discuss this in Chapter 6.

(when fresh food was less available).[484] In the twentieth century, this hog and hominy diet became deadly.

Similar to the relationship between white rice and beriberi, the rise of the epidemic may have been linked to changes in how corn meal was processed. In 1913, building off of his recent discovery of how processing impacted the vitamin content of rice, Funk hypothesized that highly milled corn might similarly be deprived of its vitamin content.[485] Other contemporaries observed how the rise of disease correlated with a new reliance on highly processed corn meal imported from a distance. At the first conference on pellagra, the South Carolina State Commissioner of Agriculture E.J. Watson gave a paper warning of the "danger of damaged grain" with corn imported into the state and "urged the need of federal inspection laws."[486] In 1912, R.M. Grimm, the first researcher sent by the Public Health Service to study pellagra in the South, noted that in the kitchens of those suffering from pellagra, the "meal was made from 'shipped in' corn which sometimes could only be described as 'sorry.'"[487] He reported that many people "lived almost entirely out of paper sacks. Few of them gardened. Most of their food was purchased from the company store or commissary, and in these stores the line of goods was meager, consisting primarily of dried or canned goods and packed meats."[488] It is possible that this imported, highly processed corn meal was especially lacking in nutrients to stave off the disease. Later scholarship has also pointed to the processing of cornmeal as a reason why the epidemic took place in the early twentieth century.[489]

However, it seems possible that the epidemic arose not only from what people *were* eating out of those paper sacks, but also what they *were no longer* eating. Grimm reported that "Few of them gardened" because this was a noteworthy change; these rural farmers were purchasing their food, not growing it. The rise of tenant farming in the late nineteenth and earlier twentieth century contributed to an increasingly monocultural landscape, one in which most farmers depended on food that was "purchased from the company store" rather than grown themselves. Even a small amount of variety a kitchen garden might add to a monotonous diet may have been enough to keep pellagra from reaching deadly stages before the twentieth century. A recent study of historical data on the boll weevil supports this idea. The study shows that in places where the boll weevil attacked cotton monocultures, where farmers were forced to diversify their crops and grow food products, rates of pellagra declined.[490] Pellagra was closely associated with monocultures, tenant

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[484] The "three M diet" created the dietary base for most poor southerners and enslaved people in the antebellum period. Bollet, "Politics and Pellagra," 218–19. Historians Kiple and Kiple have argued that pellagra, in fact, may have been prevalent among enslaved people and misdiagnosed as other diseases well before the epidemic of the twentieth century. The authors note that, during an economic depression in the 1840s, there may have been a short epidemic of pellagra among enslaved people in the South. K F Kiple and V H Kiple, "Black Tongue and Black Men: Pellagra and Slavery in the Antebellum South," *The Journal of Southern History* 43, no. 3 (1977): 411–28.

[485] Casimir Funk, "Studies on Pellagra: I. The Influence of the Milling of Maize on the Chemical Composition and the Nutritive Value of Maize-Meal," *The Journal of Physiology* 47, no. 4–5 (1913): 389–92.

[486] Lavinder, Williams, and Babcock, "The Prevalence of Pellagra in the United States. A Statistical and Geographical Note, with Bibliography," 1698.

[487] Etheridge, *The Butterfly Caste*, 47. Grimm thought this poor diet excited or exaggerated the disease, or made people predisposed to it, rather than caused the disease.

[488] Etheridge, 48.

[489] Bollet, "Politics and Pellagra," 218–20; Bryan and Mull, "Pellagra Pre-Goldberger," 20–21.

[490] Karen Clay, Ethan Schmick, and Werner Troesken, "The Rise and Fall of Pellagra in the American South," *The Journal of Economic History* 79, no. 1 (2019): 32–62.

farming, and a reliance on imported food – all of which were increasing rapidly in the early twentieth century.[491]

Both beriberi and pellagra became crises during the same period because of global developments in the industrialization of foodways. The rise of monocultures and industrialized food processing, and subsequent the decline in subsistence agriculture meant that some populations were newly dependent on a vitamin deficient, monotonous, imported diet. It is also worth noting that these diseases were especially pronounced in hospitals and prisons; as on ships, in these controlled settings the deficiency diseases could not be ignored. A key difference between the diseases has to do with taste and class: in the case of beriberi, a taste preference for white rice seems to have made the disease more widespread, while in the case of pellagra, the reliance on a monotonous diet of imported cornmeal seems to have resulted from poverty rather than a taste preference.

This divergence from our main narrative to examine the rise of beriberi and pellagra should show that the question "Why were vitamins discovered so late?" misses the ways in which, before the industrialization of food systems that started in the late nineteenth century, the fats-proteins-carbohydrates paradigm of nutrition science generally *worked*. Before industrialized food processing, monocultural development, and the decline of subsistence agriculture and kitchen gardens, most people were getting enough micronutrients from their diet to stave off deadly stages of vitamin-deficiency diseases. Vitamins only became something that attracted the attention of researchers when they were removed from diets on a mass scale outside of special circumstances of famine and sieges; when people began to get sick when they appeared to be well-fed. By focusing on the "why now?" question, we can see the way changes in agricultural labor, food processing, transportation, subsistence farming, monocultural development –in short, the industrialization of the American, and global, food system—wreaked havoc on the health of some vulnerable populations in the early twentieth century. The key word here is "some" – for many others, one should note, dietary health improved during this period. Regardless, the rise of these diseases shows that, in this new food system, the fats-proteins-carbohydrates paradigm of nutrition science no longer worked.

In some ways, the rise of beriberi and pellagra demonstrates that the skepticism of agricultural scientists in the pure food debates on the merits of new processed foods was justified; but that skepticism did not arise from the study of deficiency diseases in humans. These agricultural scientists may have partially become skeptical of the limits of nutritional knowledge from their observations of human dietaries described in Chapter 2 and in the first part of this chapter, but they also certainly became skeptical of these limits of nutritional knowledge because of their work with animals. Humans were not the only species to have vitamins unknowingly removed from their foods during this period. As scholars have pointed out, diseases caused by a deficiency in the first vitamin to be isolated and identified—vitamin A—were rare in humans.[492] More than from the investigation of human deficiency diseases, pioneering experiments in vitamin research came from the industrialization and rationalization of animal diets.

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[491] One might remember Isabel Bevier's 1898 study of the diet of African Americans in Virginia in Chapter 2 – her research subjects also ate a "hog and hominy" diet without appearing to have pellagra, but Bevier noted that: "Unbolted corn meal, costing about a cent a pound and containing a very large amount of bran, furnishes a large proportion of the diet. The coarse bran is removed by sifting, but the meal used still contains a large portion." Moreover, nearly all of the families also ate "some fish and a little milk" as well as some garden vegetables (especially cabbage, mustard greens, and kale.)

[492] Ihde and Becker, "Conflict of Concepts in Early Vitamin Studies," 32.

II. Animal Experiments and Priority Claims

The Industrialization of Animal Diets and the Single-Grain Experiment

Even considering Lind's study of scurvy and Takaki's study of beriberi among sailors, it is fair to say that the pioneering experiments that directly led to the discovery of vitamins did not stem from the study of humans; they came from the study of animals. A marked difference between the early research on pellagra and on beriberi, in fact, was the development of beriberi among chickens. In his 1912 vitamine paper, Funk reasoned that the study of pellagra as a deficiency disease was lacking because of "the impossibility of producing experimental pellagra in animals."[493] How did animals come to play such a fundamental role in vitamin research? In the United States, the use of animals which led to pioneering research on vitamins is rooted in the work of agricultural scientists in the Midwest.

There were two distinct ways that animal diets were changing during the late nineteenth century: one way was through the use of animals for experimentation, while the other was through the use of new feeds for farm animals. In using animals in a laboratory setting, scientists sought to create a controlled diet based on the fats-protein-carbohydrates paradigm, and sometimes found that the animals got sick. This was the root of the studies of the two scientists who would win the Nobel Prize for discovering vitamins—Christiaan Eijkman and Frederick Gowland Hopkins. As Kenneth Carpenter and Barbara Sutherland have recounted, in 1887, Christiaan Eijkman, a Dutch scientist in Java (Indonesia), was trying to reproduce beriberi, or polyneuritis, in chickens by infecting the animals with blood of beriberi patients, with no success.[494] Without explanation, at one point in the experiment, both the control and the experimental group of chickens developed polyneuritis. Separating the control group to a different site (under the assumption that the infection had spread), soon after, just as inexplicably, the experimental chickens began to recover. Eijkman soon learned of a key change that took place during the period that the chickens developed beriberi – an assistant had convinced the military hospital to give them leftover cooked rice to feed to the chickens. When the chickens returned to the unprocessed brown rice diet, they recovered.

Eijkman and his assistants began to experiment with different types of rice, and found that adding the silver skins—or polishings—of rice to the white rice diet cured the disease. Eijkman hypothesized that the "the envelope…contains substances indispensable to life and health that are absent or occur in too low concentrations in the nucleus of the grain."[495] Still, Eijkman did not quite argue for what would be the vitamin concept – he believed, similar to Takaki's theory, that beriberi was caused by an over-intake of carbohydrates, and that some substance in the rice polishings acted as an antidote to autointoxication. In 1896, Eijkman left Java to return to Holland due to ill health, and Gerrit Grijns took over the experiments. Conducting a series of studies using the rice polishings, as well as adding beans to the white rice diet, Grijns concluded that polyneuritis was caused by a deficiency of a vital, anti-neuritic substance. He wrote: "there occur in various natural foods substances which cannot be absent without serious injury to the peripheral nervous system…The distribution of these substances in different food stuffs is very unequal…Attempts to separate them have result in their disintegration…(showing) they are very complex."[496] With

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493 Funk, "The Etiology of Deficiency Diseases," 358..
494 Kenneth J Carpenter and Barbara Sutherland, "Eijkman's Contribution to the Discovery of Vitamins," *The Journal of Nutrition* 125, no. 2 (1995): 155–63.
495 Carpenter and Sutherland, 157.
496 Quoted in Kenneth J. Carpenter, Alfred E. Harper, and Robert E. Olson, "Experiments That Changed Nutritional Thinking," *The Journal of Nutrition* 127, no. 5 (May 1, 1997): 1025S.

this statement in 1901, Grijns described a vital substance occurring naturally in foods in varying amounts that were easily destroyed through processing and necessary to the functioning of the body. "This," writes scientist-historian Kenneth Carpenter, "was the first clear statement of what would later be called the 'vitamin' concept."[497]

Yet, continues Carpenter, "it was only published in Dutch and did not become widely known for another 25 years."[498] As groundbreaking as Grijns and Eijkman's studies were, they had little impact on American nutrition science until after the vitamin concept was generally adopted. The chemist most often associated with early vitamin research in the United States, Elmer McCollum, claimed that he did not learn of Eijkman and Grijn's experiments until 1913.[499] An English translation of the studies, in fact, was not published until 1990.[500] It seems like American, and more broadly English-speaking, scientists learned of these studies when concurrent studies in their own countries were already creating a paradigm shift. Frederick Hopkins similarly claimed that he was "quite ignorant" of the conclusions of Grijn's studies when he started his experiments in 1905 that would lead him to make a famous claim about "accessory food factors."[501]

Hopkins came to hypothesize that foods contained vital "accessory food factors" in a similar way as Eijkman and Grijns came to their conclusion. Hopkins had conducted groundbreaking research at Cambridge on amino acids by isolating different types of proteins and observing their impacts in feeding experiments on mice. In 1901, he demonstrated that tryptophan was a vital amino acid – that mice who were not fed this type of protein would stop growing and die. Unlike Eijkman, Hopkins had an idea that there were elements of diet not adequately captured in the calorimetric, fats-proteins-carbohydrates paradigm, and proved that different types of proteins had different functions. But like Eijkman, Hopkins developed his "accessory food factor" hypothesis while trying to keep experimental animals alive to study something else (in Hopkins' case, to study proteins). In giving animals a purified diet of protein (with "adequate amino acid composition"), fat, carbohydrates, minerals, and water, the mice failed to grow. Yet, adding a small amount of milk to the diet would return them to growth and health. Hopkins thus suggested, first in a speech in 1906 and later in a published study in 1912, that milk contained some "accessory food factor" vital to growth. In his 1906 speech, he stated:

> no animal can live upon a mixture of pure protein, fat, and carbohydrate, and even when the necessary inorganic material is carefully supplied the animal still cannot flourish. The animal body is adjusted to live either upon plant tissues or the tissues of other animals, and these contain countless substances other than the proteins, carbohydrates, and fats. / Physiological evolution, I believe, has made some of these well-nigh as essential as are the basal constituents of diet. […] The field is

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[497] Kenneth J Carpenter, "The Nobel Prize and the Discovery of Vitamins," The Nobel Prize organization, June 22, 2004, https://www.nobelprize.org/prizes/themes/the-nobel-prize-and-the-discovery-of-vitamins/.
[498] Carpenter.
[499] McCollum, *From Kansas Farm Boy to Scientist*, 130.
[500] Carpenter and Sutherland, "Eijkman's Contribution to the Discovery of Vitamins," 155.
[501] Sir Frederick Hopkins, speech at the Nobel Banquet in Stockholm, December 10, 1929. https://www.nobelprize.org/prizes/medicine/1929/hopkins/speech/ In the speech, he says he knew of the Eijkman studies taking place but only knew of the conclusion of autointoxication, and that he did not hear of Grijn's conclusions on deficiency until much later. Of course, we should note that in this speech, Hopkins's purpose was to make a priority claim for himself.

> almost unexplored; only is it certain that there are many minor factors in all diets which the body takes account.[502]

He further explained that diseases like rickets and scurvy are known to be connected to diet, and yet people do not precisely know what causes these disease and why certain dietary treatments work.[503] This speech provided Hopkins with the priority claim that would lead to him being dubbed the "discoverer of vitamins."

Yet at that time, Hopkins' suggestion of "accessory food factors" in the speech seems to have gone unnoticed. Historians Mark Weatherall and Harmke Kamminga have pointed out that in the discussion immediately after the speech, nobody mentioned this hypothesis. "It is clear [...] that this point was lost on his audience," they write, "and the importance of this paper lies not so much in its immediate impact as in its usefulness for Hopkins in his attempts to establish some sort of priority in vitamin research." [504] In fact, Weatherall and Kamminga question Hopkin's reputation as the "discoverer of vitamins" because this research "was for him a digression from his work on the chemistry of proteins."[505] Frustrated at the inability to isolate and chemically identify the "accessory food factor," Hopkins gave up on this line of investigation after he published in 1912. Meanwhile, other scientists continued their investigations and began isolating and identifying vitamins. Kamminga and Weatherall claim that Hopkins' reputation as the vitamin discoverer developed in 1919, when he, with a government-appointed Medical Research Committee, published a widely read report on vitamin research. This report highlighted his 1906 speech and included graphs from his 1912 study which were the "simplest, most direct expressions" of the conclusions of vitamin research.[506] The popularity of this report established Hopkins as the discoverer of vitamins.

I will discuss the Nobel Prize and priority claims in the last part of this chapter, but for now it is simply worth noting that while these experiments were taking place concurrently with Babcock's single-grain experiment, it is questionable how much these experiments impacted those taking place in the United States before 1912. Kenneth Carpenter, a historian of this subject, has claimed that Hopkins and Eijkman received the Nobel Prize because they represented two branches of investigation that led to the discovery of vitamins – the clinical branch (Eijkman) and the pure laboratory branch (Hopkins). Babcock's single grain experiment represents a third branch: the applied, agricultural branch, a branch that focused on creation of feeds for farm animals. In the United States, it was this branch that sowed the seeds of skepticism in the calorimetric paradigm.

Eijkman and Hopkins began to hypothesize a vitamin concept when their experimental animals got inexplicably sick from their controlled diet. Babcock, however, designed his single-grain experiment to prove that that fats-proteins-carbohydrates paradigm was limited. It is worth emphasizing the early date that Babcock conceived of this experiment, sometime between *1882 and 1888* (when Takaki was conducting his initial experiment on beriberi in Japan). In 1882, Babcock returned from study in Germany to begin work at the Geneva Experiment Station in New York. One of his early tasks was to make the chemical analyses of both feeding materials and the

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502 F. Gowland Hopkins, "The Analyst and the Medical Man," *Analyst* 31, no. 369 (1906): 395.
503 Hopkins, 395.
504 Mark W Weatherall and Harmke Kamminga, "The Making of a Biochemist II: The Construction of Frederick Gowland Hopkins' Reputation," *Medical History* 40, no. 4 (1996): 418.
505 Weatherall and Kamminga, 417.
506 The graphs compared two groups of rats given purified rations – one that had a small addition of milk and the other without milk. The graphs showed how the milk-fed group had a higher growth rate, which suddenly declined when the milk was taken away, and vice-versa for the group that started without milk. Weatherall and Kamminga, 419.

animal feces. At one point, as described in the introduction, "he found that when he got through and turned the results over to [the station's director]," E.B. Hart later recalled, "they were unable to tell by the analyses which was the food and which was the feces. This shook Babcock's confidence in the evaluation of feed materials by chemical analysis."[507] With his faith in chemical analysis shaken, Babcock posed this issue as a joke at "a sober meeting of the Association of Agricultural Chemists."[508] As described in the introduction, he suggested that soft coal put under chemical analysis would appear to be a healthful feed. This was reportedly met with resistance from Wilbur Atwater and other leading agricultural chemists, though Harvey Wiley, who would lead the crusade for pure food (in the previous chapter), reportedly admitted that Babcock had a point.[509] As he raised skepticism in the chemical standards of rations, Babcock began to design an experiment to prove that the *type* of food mattered; that chemical analysis alone could not accurately predict the healthfulness of a feed.

Yet it would be another twenty years before this experiment was fully carried out at the University of Wisconsin, and finally published as a bulletin in 1911. Babcock left Geneva for the University of Wisconsin in 1888, and by 1890, he had invented his world-famous Babcock butterfat test.[510] The Babcock test provided an easy and inexpensive way to measure the fat content of milk, which allowed for dairymen to sell their milk to creameries based on butterfat instead of weight. This helped to eliminate the practice of adulterating milk with water, and allowed honest dairymen to get a fair price for high quality milk. Babcock did not patent his invention, and won the trust and admiration of dairymen around the world.

This story might sound familiar – Edwin Ladd, the crusader for pure food, similarly created a grain grading system that allowed for a transparent relationship between farmers and millers, as described in the last chapter. Like Ladd, as well as Myer Jaffa, Harvey Wiley, and other agricultural chemists in the pure food debates, Babcock was also an outspoken opponent of the use of chemical preservatives. In the 1890s, he attacked the use of borax as a preservative in milk and disputed the Yale chemist Russell Chittenden's argument that the preservative was safe.[511] In his lectures to students, in 1906, he continued this argument, saying that even if they are safe in small amounts, preservatives are used to "cover up taints and defects," and that careful handling of milk, especially with the development of refrigerated railcars, obviated the need for preservatives. The possibility of misuse of borax, he argued, was "of great danger to invalids and children. Death has been reported due to indiscriminate use of the acid."[512] Unsurprisingly, Babcock was also outspoken in his support of regulating oleomargarine. "Oleomargarine is fraud," he said, "because

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[507] E.B. Hart, "Outstanding Contributions Made in the Field of Chemistry at the Wisconsin Agricultural Experiment Station," E.B. Hart papers, 1910-1953, Series 9/11/4 24I7-9, University of Wisconsin-Madison Archives, Madison, Wisconsin. (Hereafter, Hart papers, University of Wisconsin Archives.)

[508] De Kruif, *Hunger Fighters*, 277.

[509] De Kruif, 277. I have not been able to find a report or meeting notes from this famed meeting of agricultural chemists, but several sources report the same story. Howard Schneider wrote that this joke "made the agricultural chemists of the day very angry, and they appointed committees," though there is no footnote to allow the reader to look up what committees were appointed and who got angry. Schneider, "Rats, Fats, and History," 396. See footnote 404 of this chapter.

[510] Hart, "Stephen Moulton Babcock: (October 22, 1843–July 2, 1931)," 4.

[511] Wilbur H. Glover, *Farm and College: The College of Agriculture of the University of Wisconsin, a History* (Madison: University of Wisconsin Press, 1952), Chapter 7 fn. 5.

[512] Stephen M. Babcock, Lecture, April 17, 1906, Stephen Moulton Babcock papers, 1873-1934, Series 9/11/3/3, Box 1, University of Wisconsin-Madison Archives, Madison, Wisconsin. (Hereafter, Babcock papers, University of Wisconsin Archives.)

they purposely deceive the public by making them take their product when they want butter."[513] Possibly inspired by Babcock's Geneva observation and joke, chemists in the Pure Food debates would consistently argue that chemical analysis could not adequately evaluate food – that under chemical analysis, sawdust might appear to be a healthful animal feed. It is clear that Babcock, Ladd, Jaffa, Wiley, and other scientists were a part of the same tradition of nutrition science at the agricultural colleges and experiment stations that was contending with the laboratories of chemists like Atwater and Chittenden in the Northeast.

This tradition was not just based on ideas but on relationships; these western agricultural chemists were well acquainted with each other. In fact, Edwin Ladd started his career in chemistry as Babcock's assistant at the Geneva Station, and they remained in touch after Babcock left for Wisconsin and Ladd left for North Dakota.[514] In 1922, Harvey Wiley also wrote that he had "been associated professionally and on terms of intimate friendship with Prof. Babcock for nearly forty years."[515] In the 1920s, Myer Jaffa would also correspond with E.B. Hart, to share the research experiments that he was working on at the University of California and to request bulletins. Their respect for one another is evident in their letters.[516]

In 1888, when Babcock arrived in Madison, Babcock joined colleagues who had also started questioning the chemical method of evaluating feeds. Among agricultural chemists, the standard method of creating animal feeds was based on analysis of "dry matter" and protein, carbohydrates, and fat, the same paradigm that guided calorimetric studies of humans described in earlier chapters. The chemists working on animal feeds at the Wisconsin experiment station (soon to be the College of Agriculture) were William Arnon Henry (director of the station and then dean of the agricultural college), Henry Prentiss Armsby (known for his popular 1880 book on animal feeding), and Fritz Wilhelm Woll (who would help Babcock develop his butterfat test). "None of these men wholly trusted this 'official' method of chemical analysis to determine feeding practice," notes historian Wilbur H. Glover in his history of the University of Wisconsin.[517] In one dairying magazine, Henry wrote that though cornstalks appeared by chemical analysis to make a good feed, in practice they did not. "There seems to be a principle in oats that gives them value beyond that shown in chemical analysis," he wrote in another magazine.[518] While Armsby saw value in chemical analysis, he admitted that it could not be the sole guide in creating a feed: "It is doubtless true that chemical analysis alone can not finally fix the value of a feeding-stuff," he stated, "but it does furnish a reasonable trustworthy means of comparing feeding-stuffs of the same class."[519] The reluctance to strictly follow chemical standards was prevalent among the Wisconsin chemists just as it was among chemists at other experiment stations.

Why was there widespread questioning of the chemical method of analysis among scientists at agricultural experiment stations? I believe that it is because of their close work with

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[513] Stephen M. Babcock, Lecture, April 26, 1906, Babcock papers, University of Wisconsin Archives.
[514] Stephen Babcock to May Crandall, August 15, 1897, S.M. Babcock papers, 1814-1931, Wisconsin Historical Society Archives, Madison, Wisconsin. (Hereafter, Babcock papers, Wisconsin Historical Society Archives.)
[515] Harvey Washington Wiley to Hoard Memorial Committee, January 30, 1922, Babcock papers, Wisconsin Historical Society Archives.
[516] Jaffa wrote that Wisconsin's bulletin on the Antiscorbutic vitamin was is "not only of scientific value but has a practical value too." (July 5, 1922); he wrote of their research on vitamin C, "As we progress we will tell you of our results, as you may be able to help us out" (January 9, 1923); and wrote that he put the circulars that Hart had sent "to good use" (February 15, 1923). Myer Jaffa to E.B. Hart, letters 1921-1923, Hart papers, University of Wisconsin Archives.
[517] Glover, *Farm and College*, 113.
[518] Glover, 113.
[519] Glover, 113.

farmers in studying the feeding of animals – in other words, because of the applied nature of their research. Agricultural chemists and farmers alike knew that in the practice of feeding farm animals, they could not solely rely on chemical standards. Elmer McCollum wrote that when he started to research animal nutrition at Wisconsin, he realized that "by 1890 both chemists and animal husbandry men had lost faith in food analysis as a basis for planning rations."[520] In the famed 1911 bulletin, UW chemists noted that dairymen largely created rations by observing whether a food was "'agreeing' or 'disagreeing' with the animal." While the "experienced feeder" almost always gave animals a mixed ration, "the student of animal nutrition knows that he can at least satisfy the mathematical requirements of the standard by the use of" a single type of grain. Yet this "mathematical" method would produce poor results. "Probably none have felt the limitation of mathematically constructed feeding standards more than those who have taken a prominent part in their development," they explained, "and even the practical and successful feeder uses these standards only as a help, varying the kind, as well as the proportion, of total nutrients in the ration to meet the requirements of the individual." Babcock noticed that "unscientific people" would give their animals a mix of foods; and if they did not, the animals would forage. This observation was one of the foundations of the single grain experiment. "Stock feeding is an art and not a science," William Henry wrote while working at the Wisconsin experiment station. "The eye of the master fattens the cattle."[521]

Other histories of American nutrition science have noted the unique position of agricultural chemists as applied scientists. Most often, scholars point out the economic motivations that led to skepticism in the chemical paradigm. Charles Rosenberg argued that the "economic needs and political power of agriculture," rather than "physiological abstractions," was the primary concern of agricultural chemists, and through the practice of finding cheap, rational feeds they became skeptical of the chemical standards.[522] Howard Schneider similarly emphasizes the "important and obvious economic consequences" of the failure of chemical analysis of feeds. "Agricultural experiment stations smarted under this failure, and the frustration at the station at Madison was as intense as any," he states.[523] Both of these scholars may be taking their cue from McCollum's recollection of the Single Grain Experiment, in which he claims that agricultural scientists were interested in the "most economical source of protein, fat, and carbohydrate" so that the farmer could then "choose the least expensive sources of the essential nutrients and realize maximum profits."[524]

There were certainly economic motives to any scientific work on animal feeds, and without doubt, it was the economic potential for agriculture that justified the funding of the Single Grain Experiment. Yet focusing on economic motives distorts some important scientific aspects of the experiment. Work with farmers not only gave agricultural chemists an economic motive, but connected them to a network of people closely observing the feeding of animals and the results of various feeds on the animals' health and production of milk, eggs, wool, and other products. Just as a ship offered a type of laboratory for Lind and Takaki, every farm with an observant farmer acted as a nutrition laboratory. Chemists at agricultural experiment stations, especially if they had won the trust of their state's farmers, received a steady stream of letters from farmers with observations and questions about which feeds seemed to be "agreeing" or "disagreeing" with their

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[520] McCollum, *From Kansas Farm Boy to Scientist*, 116.
[521] Glover, *Farm and College*, 113.
[522] Rosenberg, *No Other Gods*, 201.
[523] Schneider, "Rats, Fats, and History," 395.
[524] McCollum, *From Kansas Farm Boy to Scientist*, 113.

animals. Farmers could make similar observations as a scientist in a laboratory. For example, one swine-raiser wrote into *Hoard's Dairyman* in 1893 that "There is something about milk which is nearly impossible to replace, that stimulate assimilation and digestion and promotes growth."[525] In 1912, when a corn crop failed in Nebraska and dairymen primarily fed wheat to their cattle, the Wisconsin college "had reported directly to us that where this practice was followed weak, and often dead calves was the result," Hart wrote to editor of *Hoard's Dairyman*.[526] Agricultural chemists recognized that the "eye of the master fattens his cattle," and drew on the observations of farmers in forming their research questions and experiments.

Another problem with the focus on economic motives is that it distorts that agricultural chemists were, in fact, interested in scientific questions. The emphasis on economic motive can imply that agricultural chemists were not aware of the contributions that they were making to the science.[527] A letter between Babcock and his former colleague at the experiment station in Geneva—chemist Charles Plumb—clearly expressed their scientific motives, which may have been the reason they both left the station for positions in Madison and, for Plumb, in Knoxville. "I hear from Geneva often, especially from Ladd and [Goff]," he wrote. "From what I can learn it will degenerate into a model farm."[528] Plumb lamented that the director of the Geneva Station refused to subscribe to the journal *Agricultural Science*, the first American journal devoted to the subject (established in 1887), of which Plumb was the founding editor.[529] " 'Agricultural Science' is thriving in every way but one," Plumb wrote to Babcock: "original contributions. This will come through."[530] The publication of original findings at the experiment station was a founding goal of the journal.[531] Aside from the obvious elements of his work – which clearly demonstrated his interest in scientific questions—Babcock's correspondence with his fiancée a decade later also makes this interest in original research clear. In 1898, he wrote, to explain why he was delaying a trip,

> I think I have discovered a fundamental law of nature and I don't want to leave until I can either confirm it or find where my mistake lies. Don't say anything of this to anyone for I may be making a fool of myself as I have so many times before when I have imagined that I had something new and found out afterwards that it had been known and rejected a hundred years before. I don't think that is the case this time, my observations are more likely to be in error and that is what I am so anxious to test.[532]

Babcock clearly expressed his interest in contributing to the understanding of "fundamental law[s] of nature."

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[525] Glover, *Farm and College*, 391.
[526] E.B. Hart to W.D. Hoard, January 4, 1915, Hart papers, University of Wisconsin Archives.
[527] Howard Schneider claims that McCollum was the "self-aware designer of the new paradigm in nutrition," implying that Babcock, Hart, and Steenbock (the other scientists who worked on the Single Grain Experiment) were not aware that they were contributing to a paradigm change. Schneider, "Rats, Fats, and History," 397.
[528] C.S. Plumb to S.M. Babcock, April 22, 1888, Babcock papers, Wisconsin Historical Society Archives.
[529] Ibid.; *Experiment Station Record, October 1917*, vol. 5, 37 (Washington DC: Government Printing Office, 1917), 405–6.
[530] C.S. Plumb to S.M. Babcock, April 22, 1888, Babcock papers, Wisconsin Historical Society Archives.
[531] *Experiment Station Record, October 1917*, 5:405–6. The *Experiment Station Record* notes that *Science*, in reviewing the journal, predicted that there would be a "paucity of original research," perhaps suggesting a bias against agricultural science, as Plumb clearly wanted to print original research.
[532] Babcock to May Crandall, April 16, 1898, Babcock papers, Wisconsin Historical Society Archives.

Scientists at agricultural colleges and experiment stations certainly had to frame their studies as having a benefit to farmers, and faced challenges from deans and directors in attempting to conduct fundamental research. This is clear in Babcock's first attempts at experiments using restrictive animal feeds. Scholars point out that his popularity from inventing the Babcock test in 1890 gave Babcock the political power to convince the dean to support a restrictive diet experiment.[533] In the 1890s, Babcock was able to conduct his first restrictive diet experiment – possibly referred to in the above letter—but he was given two cows. When both weakened and one died within months, the experiment was called off. The college could not justify conducting experiments that killed cattle.[534]

In 1906, the college of agriculture hired chemist Edwin Bret Hart, and he was given support to carry out Babcock's single-grain investigation. Hart was joined by G.G. Humphrey (professor of animal husbandry) in carrying out the experiment, and they brought on two more scientists after they started: Elmer McCollum (who had just earned his PhD from Yale, and was hired to make chemical analyses) and Harry Steenbock (a graduate student in agricultural chemistry). The experimenters were given sixteen calves, animals so young that they would only know their experimental ration. They divided the calves into four groups: three groups would be given a ration perfectly balanced according to chemical analysis but composed of a single plant – oats for one group, corn for another, and wheat for the third. The fourth group would be given a mixture of the three grains, because, as Babcock had earlier observed, experienced husbandmen most often gave their animals a mixed feed. They acknowledged that chemical standards worked as a general guide for husbandmen giving a mixture of feeds. "Such standards expressed mathematically will always be of value because of their definite form, and it is just such definite information that the practical feeder wants," they wrote. "The kind of nutrients" or the source of food materials, they explained, "*receives [the dairyman's] attention only when their effects are extremely pronounced and immediately apparent*" [their emphasis].[535] They thus justified giving the animals single-grain rations, without allowing them to forage, in order to examine the health impact of chemically identical and materially different foods through exaggerated results. "It is true that our rations, fortunately, so exaggerated the ultimate effects as to make them unmistakable," they wrote in their 1911 bulletin.[536]

The researchers framed the experiment as testing whether the *chemical value* of a ration was a true measure of "what may be called the *physiological value* of a ration."[537] This comparison of chemical versus physiological value was similar to the skepticism of chemical values in the concurrent Pure Food debates, as well as of the remarks by dietary surveyors who questioned whether chemical standards could capture the practical value of a food. These terms of physiological value and chemical value were consistently used in framing the single-grain experiment throughout the sources. The 1908 report of the experiment stated that they were investigating whether "chemical analysis" could adequately predict the "physiological effect of the different constituents in feeding stuffs."[538] They hypothesized that there were elements of food

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533 Schneider, "Rats, Fats, and History," 395.

534 Glover, *Farm and College*, 116. "When one of the cows selected for this experiment died, Carlyle withdrew the other, and the famous nutrition experiment went on the shelf for awhile," Glover writes.

535 Hart et al., *Physiological Effect on Growth and Reproduction of Rations Balanced from Restricted Sources*, 1911, 132.

536 Hart et al., 198.

537 Hart et al., 132.

538 H.L. Russell, *Report of the Director, 1908*, The University of Wisconsin Agricultural Experiment Station Bulletin 171 (Madison, WI, 1909), 8.

that were not captured in chemical analysis but that had physiological value. "The rations ordinarily fed our farm animals are exceedingly complex in chemical composition," they explained.

> There are many different proteins, in addition to nitrogen-bearing bodies of non-protein character; fats of different composition and degree of saturation; carbohydrates of many types; and *almost a host of undetermined and undefined bodies in the daily ration of a domestic animal*.[539] [my emphasis]

They thus designed the experiment to determine whether there was "a physiological value to the ration not determinable by total intake of digestible nutrients, nor by a measurement of its production energy value."[540] They designed the experiment to challenge the calorimetric paradigm based on fats, proteins, and carbohydrates.

To adequately assess whether there was a physiological value to a ration, the investigators argued that the experiment needed to be carried out for a long period of time. "In the present state of our knowledge," they wrote, "the physiological value can be determined […] only by long continued observations of the reaction of the feed on the animal."[541] In the first year of the experiment, in fact, they did not see any differences between the groups of calves. "Make it a lifetime of these creatures," Babcock said, according to De Kruif. "Make the experiment like life itself!"[542] The first variation the scientists observed was not a difference in weight, but a difference in appearance: the corn-fed cattle had smooth, full coats; the wheat-fed cattle had rough, thin coats. The wheat-fed cattle also started wagging their head and rolling their tongues. The corn- and the wheat-fed calves were seemingly the ends of a spectrum of health, with oats and the mixed diet (which was discontinued) in between. When the experimenters began to breed the cattle after two years, the results became obvious. The corn-fed cattle gave birth to healthy, large calves; the wheat-fed gave birth prematurely to underweight calves, who died within a few hours of birth. The results showed how "[s]hort periods of experimentation are absolutely useless and can give no definite and conclusive answer to the questions involved."[543]

More importantly, the results made clear the errors of chemically composed rations. "The experiment has opened a wide field of inquiry that is sure to lead to most important results in the matter of animal nutrition," the experimenters excitedly reported in 1909. "It is apparent that the usually accepted dictum that a chemical analysis is all that is necessary to balance properly a suitable ration, is far from correct."[544] After that report, they switched the rations of the animals, and found that the cattle given a corn diet improved in health, while the health of the cattle now given a wheat diet declined. At first the cows that switched from the corn diet to the wheat diet refused to eat, "which would make it seem that cows may be smart, without science," De Kruif noted in his history.[545] When they did begin to eat the wheat diet, they experienced swollen joints

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539 Hart et al., *Physiological Effect on Growth and Reproduction of Rations Balanced from Restricted Sources*, 1911, 132.
540 Hart et al., 133.
541 Hart et al., 133.
542 De Kruif, *Hunger Fighters*, 287.
543 Hart et al., *Physiological Effect on Growth and Reproduction of Rations Balanced from Restricted Sources*, 1911, 135.
544 H.L. Russell, *Report of the Director, 1909*, The University of Wisconsin Agricultural Experiment Station, Bulletin 193 (Madison, WI, 1909), 16.
545 De Kruif, *Hunger Fighters*, 293.

and difficulty moving. There was clearly some factor that made a difference between the corn and wheat ration that their chemical analysis had not identified.

Hart, Humphrey, McCollum, and Steenbock conducted tests to rule out the suspected scientific explanations for their results, such as contagious disease, differences in proteins, differences in mineral content, and autointoxication or some sort of toxic substance in wheat.[546] "In view of all the facts presented," they concluded, "it appears to us that there is a decided physiological value to our feeds, whose proper or improper combination may make for vigor, resistance, and splendid condition, or for weakness, low resistance, and poor condition in the individual."[547] Their experiment had shown there was a physiological value to rations that could not be explained by current scientific knowledge. "What particular part of the plant was responsible for these reactions is as yet unascertained," they wrote. "At the present time we have no adequate explanation of our results."[548]

The results of the single-grain experiment were published in the famous Bulletin #17 in 1911. Without an "adequate explanation" of the results, their main conclusion was to show "the inadequacy of present methods of research" in nutrition based on "digestible nutrients and energy," and to propose a new method of research.[549] "The gist of the whole matter is this," E.B. Hart wrote to W.D. Hoard in 1911, "certain rations compounded to satisfy our present standards fail entirely to support the physiological vigor demanded of the animal. […] there are hidden influences of feeds which are not measured by our present chemical analyses and by the total energy a feed may contain."[550] They emphasized that their goal was not to compare the value wheat and corn; that the investigation "suggests a method […] rather than establishes final values for any part of these rations."[551] To determine the physiological value of a ration, one had to make a long-term observation of the impact of a ration on a group of animals. "In my judgment," Hart wrote, "it opens up a field of inquiry of great importance and one which can be prosecuted only where a number of animals and long continued observations are possible."[552]

The investigators understood that this new "field of inquiry" applied to both animal *and* human nutrition. "[T]he results are so decisive that their bearing on the whole subject of both human and animal nutrition cannot be ignored," they wrote in 1911. "[S]uch specific and experimentally established information is to-day lacking in both fields of human and animal nutrition."[553] They wrote that the type of experiment they conducted would be impossible to make for the "human family involving as it does the use of a special ration for a long time and the influence of such a ration on the producing capacity of the mother and the size and vigor of the young," thus noting ethical reasons for not experimenting in human nutrition (rather than for lack of interest).[554] They noted that some people do employ restrictive diets, though not for experimental purposes. At this point, one cannot help but think of Jaffa's study of the fruitarians – a voluntary, restrictive diet which he observed for a long period of time—nor can one help but

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[546] Hart et al., *Physiological Effect on Growth and Reproduction of Rations Balanced from Restricted Sources*, 1911, 199.
[547] Hart et al., 203.
[548] Hart et al., 199.
[549] Hart et al., 197.Bulletin #17, 197.
[550] E.B. Hart to W.H. Hoard, December 6, 1911. Hart papers, University of Wisconsin Archives.
[551] Hart et al., *Physiological Effect on Growth and Reproduction of Rations Balanced from Restricted Sources*, 1911, 198.
[552] Hart to W.H. Hoard, December 6, 1911. Hart papers, University of Wisconsin Archives.
[553] Hart et al., *Physiological Effect on Growth and Reproduction of Rations Balanced from Restricted Sources*, 1911, 134.
[554] Hart et al., 134.

to think of Wiley's poison squad, which he hoped to show by long observation the harmfulness of chemical preservatives. Wiley and Jaffa were certainly interested in a similar research goal – measuring the physiological value of a diet through long-term observation. Harry Steenbock later reflected that at the time "far less concerted effort had been directed to find out the needs of the human than of the animal," but that he and the other single-grain investigators believed that what was "true for animal rations was true to a still greater degree for human rations."[555] "The evidence for the necessity of giving much weight to the *physiological* influence of the ration, apart from its digestible protein content and calorific value, is positive," Bulletin #17 concluded, and this fact "should emphasize strongly the necessity for further study with all classes of farm animals, as well as in human dietetics, of the physiological value of various rations and diets."[556]

"The whole problem of animal nutrition takes on new phases and new meanings from this work," Hart wrote in 1915, in a letter in which he compared the single-grain experiment to the studies of rice and beriberi in Asia. "I am inclined to think that with wheat we are dealing with a somewhat similar problem." In the same year that they published Bulletin #17, Casimir Funk had claimed to have isolated the factor in the rice polishings that, when added to the white rice diet, prevented and cured beriberi. He called this a "vitamine", assuming that it was a type of "vital amine" (it would later be shown that he was incorrect, and the word was changed from "vitamine" to "vitamin"), and he hypothesized that pellagra and scurvy might be caused by a deficiency in these micronutrients. One year later, in 1912, Hopkins published his research on the purified diet of experiment rats, in which he proposed that there was some "accessory food factor" in milk that allowed for rats on a purified diet to grow, though he did not continue this research to find out exactly what that factor was. The Wisconsin scientists, meanwhile, were working to try to identify what factor, exactly, was missing in the wheat diet and available in the corn diet that caused the health disparities. Hart noted in his letter in 1915 that they had found that when milk, casein, or butterfat was added to the wheat ration, the animals' health improved.[557] In fact, at Wisconsin, research was underway that would identify a fat-soluble "factor A" in butterfat that was different from the water-soluble "factor B" in rice polishings. The single-grain investigator who would become associated with this research was Elmer McCollum.

Elmer McCollum was hired in 1907 to do the "analytical grunt work" for the single-grain experiment, which was already underway. "I had never analyzed a food by chemical methods," he later reminisced, "nor had I ever conducted an animal experiment."[558] Through chemical analysis, McCollum was expected to investigate what might cause the differences in health outcomes between the feeds. It is difficult to tell what his opinion of the experiment was during this initial period. He wrote in his autobiography that upon joining the experiment it was clear that it showed "something fundamental that remained to be discovered," but he also wrote that he tired of the experiment when he was unable to identify a toxic substance in the wheat even though "Professor Hart and all staff members thought it the outstanding nutrition study of all time" and the experiment was gaining more and more attention from students of agricultural science.[559] McCollum began to look into other similar experiments by reading Maly's Yearbook at night, and

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[555] Harry Steenbock, "Certain Experiences in a Laboratory of Nutrition," lecture on November 30, 1925, Harry Steenbock papers, 1905-1960, Series 9/11/13 24M5-N9, University of Wisconsin-Madison Archives, Madison, Wisconsin. (Hereafter, Steenbock Papers, University of Wisconsin Archives.)
[556] Hart et al., *Physiological Effect on Growth and Reproduction of Rations Balanced from Restricted Sources*, 1911, 163.
[557] E.B. Hart to W.D. Hoard, January 4, 1915, Hart papers, University of Wisconsin Archives.
[558] McCollum, *From Kansas Farm Boy to Scientist*, 112.
[559] McCollum, 115, 116.

found that between 1873 and 1906, there were thirteen experiments in the yearbook in which scientists could not keep experimental animals—most often mice—alive on a purified diet. McCollum claimed that this discovery made him realize that "the most important problem in nutrition was to discover what was lacking in such diets. They contained everything that chemists, physiologists, and medical men considered essential, yet when fed to mice they proved wholly inadequate for the maintenance of life and health."[560] This was just what the single-grain experiment was demonstrating as well.

McCollum soon suggested that they conduct experiments using rats instead of cows. Rats had shorter life cycles and "ate by the gram and not the kilo," which might allow McCollum to "get out from under the drudgery of those endless analyses connected with the consuming cows."[561] E.B. Hart, McCollum's superior, and Dean Henry Russell, however, rejected the idea. They were an agricultural college in a dairying state, and they had chosen to use heifer cows for the single-grain experiment specifically because of "their relation to the dairy industry." This is an example of applied science resisting fundamental research at the agricultural colleges, though it's worth noting that the researchers had a point in not trusting that the experiments on one animal could then be applied to another. "[T]he effect of rations on physiological vigor with one species may not with safety be translated in the same terms for another species," they wrote in a footnote in Bulletin #17.[562] Though they recognized that the implications of the inadequacy of chemical analysis in planning diets applied to all species, they did not assume specific rations could translate between species.[563] However, Babcock liked McCollum's idea, and convinced Hart and Henry to allow McCollum to begin experiments on rats (though at first he did not get funding for this, and paid for it out of pocket). This use of rats as research subjects would turn out to be fundamental to the ability of scientists to measure the physiological value of foods through long-term observation, as the single-grain experiment had concluded was necessary for understanding the value of a food.

At first, McCollum hypothesized that purified diets did not maintain the health of experimental animals because of lacking *palatability* of the purified diets. This is another example the shows how important palatability was to early nutrition scientists. Indeed, the single-grain experimenters noted that they chose calves for the experiment so they would not be accustomed to foods of "high flavor and relish" – and noted that they ate their single-grain foods with "good appetite and relish."[564] McCollum said he was inspired to consider palatability by Pavlov's dogs, which emphasized "the importance of the psychic responses of dogs to the chemical nature of food given to them." He continued,

> This influence on the physiological effects of food apparently depended primarily upon taste. For this reason I directed my earliest efforts in experimenting toward

[560] McCollum, 117.
[561] Schneider, "Rats, Fats, and History," 399.
[562] Hart et al., *Physiological Effect on Growth and Reproduction of Rations Balanced from Restricted Sources*, 1911, 135.
[563] It's worth noting the example of vitamin C, which most animals, including rats, produce themselves, and thus do not need it in the diet. In fact, because researchers like McCollum could not produce experimental scurvy in rats, they remained resistant to the idea that scurvy was caused by a vitamin deficiency.
[564] Hart et al., *Physiological Effect on Growth and Reproduction of Rations Balanced from Restricted Sources*, 1911, 142. They in fact concluded that this showed the possibility that animals could be accustomed to a monotonous diet. Hart et al., 143.

making my insipid diets more palatable, without adding any nutrient other than the isolated and purified substances known to be essential.[565]

By 1909, having secured growth seemingly by including "a variety of carbohydrates—starch, sugar, milk sugar—exposed the food to odor from steam of old cheese, and included freshly rendered bacon fat, etc." he concluded that palatability was the missing factor for growth.[566] In 1911, however, other researchers –Thomas Osborne and Lafayette Mendel - noted in a conference paper that he had committed errors in the experiment: he had not fully purified the milk sugars, and he had allowed the rats "access to their excreta."[567] They instead were convinced that it was an issue with the types of proteins that caused the inadequacies of purified diets. "Their paper embarrassed and humiliated me," McCollum later wrote.[568]

Yet McCollum did not give up on his investigation of the causes of the issues of the purified diet, and Osborne and Mendel pursued this research as well. In 1909, Marguerite Davis, a graduate from UC Berkeley, joined the Wisconsin experiment station to volunteer to take care of the rats in McCollum's experiments (Despite McCollum's requests, Hart refused to pay Davis for years.[569]) McCollum later wrote that Davis's work was fundamental to his research, which, he had painfully learned, required close attention to the experimental animals. He and Davis had their first major breakthrough in 1912, when they discovered that rats on a purified diet with fat derived from butterfat or egg yolk maintained good health while rats on a diet with fat from lard or olive oil declined in health. With this experiment, McCollum gained the support of Dean Russell and the University for using rats as experimental animal, because with this experiment, he had demonstrated the superiority of butter to margarine, something pure food crusaders, especially in Wisconsin, had been arguing for years. "We must get this discovery published right away," McCollum recalled Dean Russell telling him. "It is the first club we ever had to kill the butter substitute industry."[570]

Their 1913 paper – "The Necessity of Certain Lipins in the Diet during Growth"—in some ways looks like a continuation of the pure food debates.[571] Experiments on purified diets generally had implications on the debate over "natural" and "artificial" foods, as Dean Russell clearly saw. The word "pure" changed meanings in these experiments compared to the pure food debates: in the pure food debates, "pure" meant natural or traditionally processed foods, while in scientific experiments, "purified food substances" meant just the opposite – a diet that has been chemically processed to solely contain the desired macro-nutrients. But scientists similarly used the words "natural" and "artificial," and additionally used the words "organic" and "inorganic." Davis and McCollum noted that the rats they placed on a purified diet would stop growing (though they maintained health), but when their diet changed to "naturally-occurring foodstuffs," they resumed growth.[572] This observation, they wrote, "would lead one to the belief that on these mixtures of

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[565] McCollum, *From Kansas Farm Boy to Scientist*, 122.
[566] McCollum, 131.
[567] McCollum, 133.
[568] McCollum, 132.
[569] McCollum wrote: "Though she did not need to support herself I felt it was unfair not to give her a salary." McCollum, 124.
[570] McCollum, 145.
[571] Elmer Verner McCollum and Marguerite Davis, "The Necessity of Certain Lipins in the Diet during Growth," *Journal of Biological Chemistry* 15, no. 1 (1913): 167–75.McCollum and Davis used the word "lipin" to mean a complex fat (or lipid).
[572] McCollum and Davis, 168.

purified food substances the animals run out of some organic complex which is indispensable for further growth but without which maintenance in a fairly good nutritive state is possible."[573] The addition of the ether extract (fat content) from butter or egg yolk to the diet allowed for rats to grow, but, they stated, "In no instance have we obtained such a result by the feeding of lard, or of olive oil." It thus showed that different fats had different health values – though they still needed to investigate whether this was due to "some indispensable organic complex of the chemical nature of the lipins, or […] a stimulating action of some substance accompanying the lipins."[574]

McCollum and Davis placed their experiment in the context of the experiments of scientists like Hopkins (1912) and Funk (1912) to conclude that their study "strongly supports the belief that there are certain accessory articles in certain food stuffs which are essential for normal growth for extended periods."[575] McCollum and Davis's experiment was particularly new because they were examining *fats*, whereas most nutrition researchers were focusing on differences between *proteins* (after all, Funk thought that the vital element was an *amine*). In 1914, McCollum further homed in on the exact substance in the butterfat through saponification, which allowed him to create an extract from the butterfat that did not contain fat to olive oil. The rats given this extract and olive oil resumed growth.[576] By 1916, McCollum and fellow researcher Cornelia Kennedy were proposing that scientists label the identified substances "fat-soluble A" (which they had identified in butterfat and egg yolks) and "water-soluble B" (which researchers had identified in rice polishings).[577] This naming system would be the basis of the naming system used today.

Though McCollum would later claim that he and Davis had "discovered Vitamin A," scientist-historian Richard Semba has pointed out that it may be better to think of his paper as a part of a number of experiments proving that there existed organic, accessory substances in foods necessary for health and growth (after all, it would later be proven that McCollum's extract contained three different vitamins).[578] Osborne and Mendel were carrying out similar experiments on butterfat at the same time, and a host of other scientists – perhaps most prominently, Holst, Funk, and Goldberger—were publishing papers that were narrowing in on the exact vital substances in foods that could prevent or cure beriberi, scurvy, or pellagra. Scientists could demonstrate that there existed substances that produced varying effects in experimental animals, but they had not isolated these substances or identified their chemical structure. McCollum and Osborne and Mendel strongly questioned the existence of an antiscorbutic vitamin (today we would call vitamin C) because they could not reproduce scurvy in rats. This research –like most scientific research—was messy, and it is only in retrospect that we can construct narratives that seem to follow straight paths to vitamins A, B, and C.

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573 McCollum and Davis, 168. Ibid., 168. Hart and McCollum's 1914 paper also summarized the results of the Davis/McCollum experiment in the terms of "natural" and "artificial": "In connection with this consideration of the restricted natural diet it should be stated that the work of McCollum and Davis, and later confirmed by Osborne and Mendel, has established the necessity in the artificial diet for growth of some substance or substances not contained in purified proteins or carbohydrates supplemented with a suitable ash mixture." EB Hart and EV McCollum, "Influence on Growth of Rations Restricted to the Corn or Wheat Grain," *Journal of Biological Chemistry* 19, no. 3 (1914): 374.

574 McCollum and Davis, "The Necessity of Certain Lipins in the Diet during Growth," 174..

575 McCollum and Davis, 174–75.

576 Carpenter, Harper, and Olson, "Experiments That Changed Nutritional Thinking," 1030S.

577 According to Patricia Swan's research, Cornelia Kennedy first used this naming system in her thesis in 1916 (McCollum was her adviser). McCollum and Kennedy then published a paper together that proposed this naming system. P B Swan, "Cornelia Kennedy (1881-1969)," *The Journal of Nutrition* 124, no. 4 (1994): 455–56.

578 Richard D Semba, "The Long, Rocky Road to Understanding Vitamins," in *The Vitamin A Story* (Basel, Switzerland: Karger Publishers, 2012), 82.

The other scientists who had worked on the Single-Grain Experiment were also continuing these lines of investigations. In 1914, Hart and McCollum published a second single-grain experiment on swine and rats, and found that adding butterfat and casein to the wheat ration of swine would produce normal growth.[579] Though Harry Steenbock had left the experiment station briefly from 1912-1913, to study with Lafayette Mendel at Yale and then Carl Neuberg in Berlin, he returned to earn his PhD in 1916 and began studies investigating what looked like rickets in experimental animals.[580] This would lead him to develop a groundbreaking food fortification process that is the subject of Chapter 5, but for now it is worth noting that he started these experiments at Wisconsin during this period. In 1917, Hart, McCollum, Steenbock, and Humphrey published a final paper on the single grain experiment. They wrote that when they started their study, the standard for a ration was simply "total digestible protein and energy" expressed mathematically, but

> today we would consider a ration complete and efficient only when it contained protein of adequate quantity and quality, adequate energy, ash materials in proper quantity and proportion and two factors of unknown constitution (vitamins), designated from this laboratory fat soluble A and water soluble B.[581]

They again framed their experiment as ultimately challenging the quantitative chemical method of analysis. There were many nutritional factors "not measurable by any quantitative chemical method" and through the identification of new factors created "a desire for a mathematical expression of these factors in feeding standards […] It is doubtful if this can ever be done, at least for certain of them."[582]

Despite their early research challenging the calorimetric paradigm and their ongoing research into vitamins, the scientists at the Wisconsin Experiment Station have received less recognition than expected as pioneers in early vitamin research –with the exception of Elmer McCollum. In 1917, McCollum left the University of Wisconsin for Johns Hopkins University. That year, and that event, might mark the beginning of the burying of Western agricultural experiment stations in the history of American nutrition science.

Lone Wolf Narratives: Priority Claims, the Nobel Prize, and Historical Distortion

McCollum's departure from the University of Wisconsin was anything but civil. "Before McCollum entirely severed his connection with the University," Harry Steenbock recounted in 1922, "he did everything he possibly could to hamper the successful execution of experimental work in nutrition."[583] As scientist-historian Richard Semba has chronicled, Dean Russell noted in

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[579] Hart and McCollum, "Influence on Growth of Rations Restricted to the Corn or Wheat Grain." In McCollum's autobiography, he writes about the experiment on swine as if he alone conducted it. McCollum, *From Kansas Farm Boy to Scientist*, 134–35.
[580] Howard A. Schneider, "Harry Steenbock (1886–1967) A Biographical Sketch," *The Journal of Nutrition* 103, no. 9 (1973): 1238.
[581] Edwin Bret Hart et al., "Physiological Effect on Growth and Reproduction of Rations Balanced from Restricted Sources," *Proceedings of the National Academy of Sciences* 3, no. 5 (1917): 374.
[582] Hart et al., 375.
[583] Steenbock to Dr. H.H. Sommer, March 29, 1922, 9/11/13/2: Box 1: Folder 11 "Mc-Mz", Steenbock Papers, University of Wisconsin Archives. Steenbock wrote this in a letter to the Dairy Science Club, upon hearing that they were thinking of inviting McCollum to speak at the university. He wrote that it would be "a decided insult to Dr. Babcock as well as a matter of questionable propriety to invite a man of this caliber to speak."

his diary that Steenbock, at the time a graduate student, had a hostile conversation with McCollum before he left, in which Steenbock reported that "McCollum was averse to giving him much of any information, said that from now on they were scientific rivals."[584] Before leaving, McCollum released all of the rats in the experiment station (which Steenbock would spend months recapturing), and more importantly, "Upon McCollum's departure, all the research notebooks in the Wisconsin agricultural station disappeared."[585] These included all of Harry Steenbock's research notebooks.[586]

Soon after, allegedly the data and direct quotes from Steenbock's notebooks appeared in articles in the *Journal of Biological Chemistry* – articles in which McCollum listed himself and his assistant Nina Simmonds as authors.[587] The controversy over McCollum's plagiarism played out on the pages of *Science* in spring of 1918 through letters from Hart, Steenbock, and McCollum. Though Steenbock had been pursuing independent research when McCollum left, McCollum claimed that *he* had planned the experiments and Steenbock had simply carried them out. "[D]uring my stay at the University of Wisconsin nobody had anything to do with independent work with my rat colony," McCollum stated, "there is no property right in research or its results so long as it is incomplete and not protected by patent."[588] McCollum further wrote that the public could judge who they thought planned the experiment "on the basis of the research records of all concerned"— a bit of an unfair statement considering Steenbock was a graduate student.[589] *Science*, the University of Wisconsin, and Steenbock agreed that there was more to lose than to gain in dragging out the conflict with McCollum, and so the controversy ended unresolved.[590]

Yet this controversy would have lasting consequences: McCollum would go on to be a prolific writer and historian of American nutrition science. He thus had pronounced sway over how the history was told, and his soured relationship with the Wisconsin scientists seem to have shaped that history.

In 1918, McCollum published his first comprehensive book on nutrition science, *The Newer Knowledge of Nutrition*. In this book, McCollum presented himself as *the* discoverer of vitamins. Semba notes in his history of vitamin A that McCollum mentioned his own name about seventy times throughout the book "and, feigning a kind of remote objectivity, referred to himself in the third person. Few of the dozens of major investigators contributing to the 'newer knowledge' received more than a passing mention, including F.G. Hopkins, Osborne and Mendel, Stepp, and his own one-time collaborator, Steenbock."[591] In this book, McCollum also claimed that "pellagra, scurvy, and rickets do not belong to the same category with beriberi"—that the only vitamin deficiency diseases related to fat-soluble A and water-soluble B (He would not mention

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[584] Semba, "The Long, Rocky Road to Understanding Vitamins," 86.
[585] Semba, 86.
[586] Steenbock wrote that they contemplated having McCollum arrested for the theft. Steenbock to Dr. H.H. Sommer, March 29, 1922, 9/11/13/2: Box 1: Folder 11 "Mc-Mz", Steenbock Papers, University of Wisconsin Archives.
[587] Semba, "The Long, Rocky Road to Understanding Vitamins," 86.
[588] Quoted in: Semba, 87.
[589] Quoted in: Semba, 87. Steenbock, however, would end up conducting related, groundbreaking research on vitamin D in the 1920s, which is the subject of Chapter 5. In Steenbock's reply in *Science,* he noted that the 1916 station report gives Steenbock full credit for this experiment. Steenbock, "Professional Courtesy," *Science*, 1918; 9/11/13/2: Box 1: Folder 10 "McCollum", Steenbock Papers, University of Wisconsin Archives. In his autobiography, McCollum denied all of these accusations.
[590] Dr. J. McKeen Cattell, editorial department of *Science,* to Harry Steenbock, April 6, 1918; Steenbock to Cattell, April 8, 1918, 9/11/13/2: Box 2: Folder 13 "R-Sd", Steenbock Papers, University of Wisconsin Archives.
[591] Semba, "The Long, Rocky Road to Understanding Vitamins," 88.

these erroneous statements in his later histories).[592] Though he did discuss the single-grain experiment, he placed himself as the leader in recognizing the fundamental contributions of the experiment and, he wrote in his autobiography, in "perfect[ing] what I called the 'biological method for analysis of food.'"[593] McCollum certainly did contribute to the development of this method through the use of rats as experimental animals for nutrition research, but he did not come up with the idea of a "biological method." The primary objective of the single-grain experiment was to demonstrate that a *physiological* method of analysis – long-term observation of a group of animals—was needed to understand the real value of a diet. Throughout his writings, McCollum would strategically downplay the contributions of the Wisconsin scientists to vitamin research in order to support his own priority claims in vitamin research.

McCollum's claims to priority in vitamin research not only put him at odds with the Wisconsin scientists, but also with other scientists in the field of vitamin research, especially Osborne and Mendel. "A break in friendly relations with Dr. Osborne and Professor Mendel occurred in connection with the question of priority of discovery of the first of the fat-soluble vitamins now known as vitamin A," McCollum later wrote in his autobiography.[594] McCollum in fact claimed in this autobiography that Mendel had been inspired to conduct research on vitamin A only upon seeing McCollum's unpublished experiments, which had been submitted to the *Journal of Biological Chemistry* (of which Mendel was an editor).[595] Yet in 1919, the reasons for this break in relations were discussed in a somewhat different way. McCollum in fact wrote to Mendel because he had heard that Osborne had spoken poorly of him, to ask Mendel why that was. Mendel answered honestly, to say that he believed that

> Osborne has been frankly outspoken with respect to one aspect of your attitude towards the subject of nutrition—and in this he has not stood alone. From year to year your publications have revealed what seems to be a growing studied indifference to the contributions of other persons to the development of the science. The climax was reached in your recent book which (at least, so it intimated) seemingly makes you alone responsible for the new progress in nutrition.[596]

Mendel said that this criticism was not limited to Osborne. McCollum had gained a widespread reputation as a poor collaborator as well. Hart wrote that many workers at the Wisconsin experiment station were in fact relieved when McCollum left; that though McCollum was "capable individualist," he was "a poor operator on a team."[597] At his new institution, McCollum continued to have that reputation. The dean of the Johns Hopkins School of Hygiene and Public Health wrote that McCollum was a "lone wolf who liked to have assistants, usually women, rather than co-workers."[598]

While McCollum had a noteworthy reputation for belittling others, he was not alone in emphasizing his own research as groundbreaking in attempting to make a priority claim. As Aronson has written, scientists making priority claims often emphasized individuality and resistance – or the barriers to discovery that they overcame –rather than the precursors to scientific

[592] Quoted in: Semba, 88.
[593] McCollum, *From Kansas Farm Boy to Scientist*, 124.
[594] McCollum, 131.
[595] McCollum, 149.
[596] Quoted in Semba, "The Long, Rocky Road to Understanding Vitamins," 91.
[597] Quoted in Semba, 87.
[598] Quoted in Semba, 92.

discovery.[599] This is despite the fact that many scientists at the time recognized the issues in individualistic accounts of progress in nutrition. "Science grows in part by correcting and supplementing earlier work," Mendel ended his letter to McCollum, "not primarily by disparaging it."[600] The possibility of winning a Nobel Prize somewhat eroded this sentiment, as scientists, even in recognizing the contributions of others, still emphasized their own individual breakthroughs while belittling other breakthroughs. In the years before the prize for vitamin discovery was awarded to Hopkins and Eijkman in 1929, there was a clear contest for the prize, as multiple scientists – including Hopkins, Eijkman, Grijns, Goldberger, Funk, and Suzuki (a Japanese scientist who worked on beriberi)—were nominated. In McCollum publishing *The Newer Knowledge of Nutrition* in 1918, and in Hopkins publishing his 1919 booklet on vitamins, both scientists were certainly aware that the Nobel Prize was at stake; both were writing themselves into the history as the discoverer of vitamins (to no discredit to their groundbreaking research.) Funk addressed this growing competition in 1926 in a *Science* article titled "Who Discovered Vitamines?" Though Funk concluded the article by declaring that "the discovery of vitamines cannot be attributed to any one man," most of the article was devoted to belittling Hopkins' priority claim.[601] Funk wrote that Hopkins only gained the reputation as the discoverer of vitamins after his widely read 1919 booklet was published; that he had little influence on the early vitamin research, and that Hopkins's 1906 speech, though showing "unusual perspicacity," was not all that unique from observations other scientists had made on animals on a purified diets.[602] Despite his statement that no one person could claim priority, he also made strong arguments for his own role in the discovery of vitamins –mainly to show that he had a stronger priority claim than Hopkins.

Despite Funk's arguments, in 1929, Hopkins won the Nobel Prize for Medicine alongside Eijkman. In his acceptance speech, Hopkins agreed with Funk that there was no one "discoverer of vitamins," and he outlined earlier work that foreshadowed the discovery of vitamins and thus had "deprived perhaps every individual worker of that clear title."[603] Yet in this early work that foreshadowed the vitamin concept, researchers were often unaware of this fundamental discovery, Hopkins claimed, and in any case, this work had little influence on the discipline. "It is sure that, until the period 1911-1912, the earlier suggestions in the literature pointing to the existence of vitamins lay buried," he asserted.[604] Like others making priority claims, Hopkins stated that he was ignorant of these earlier experiments when he began his research, and, as others belittled the work of other scientists, Hopkins belittled Funk's early papers on vitamins.[605] Hopkins defended his winning of the prize by disputing Funk's claim that Hopkins had had little influence on early vitamin research. In fact, in this defense, Hopkins specifically claimed that his experiments had sparked the groundbreaking research on vitamins *in the United States*. "Very soon after my chief paper appeared the study of vitamins was, as you know, developed with great energy and success in the United States," he stated. "We owe especially to Osborne and Mendel, and to McCollum and his co-workers, the all important work which continued during the earlier years of the war."[606]

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599 Aronson, "The Discovery of Resistance."
600 Semba, "The Long, Rocky Road to Understanding Vitamins," 91.
601 Casimir Funk, "Who Discovered Vitamines?," *Science* 63, no. 1635 (1926): 455–56.
602 Funk.
603 Sir Frederick Hopkins, speech at the Nobel Banquet in Stockholm, December 10, 1929.
604 Ibid. He stated that there was no evidence that these early studies were "affecting the orientation of any authoritative teaching concerning the phenomena of normal nutrition either at the time in question or indeed, in any effective sense, before."
605 Ibid.
606 Ibid.

Hopkins explained that the distinction between "water soluble" and "fat soluble" vitamins was particularly important and pioneering. "So prominent indeed was the American work at this time," he continued,

> and so large a proportion did it form of the total output from 1912 to near the end of the war that, if I wished to claim that my own publications exerted any real and effective influence in starting a new movement in the study of dietetics, I should have to convince myself that they helped to direct the thoughts of the Harvard and Baltimore investigators. Anyone reading with care the succession of papers describing their experimental studies before and after the appearance of my own publications in 1912, will, I think, become convinced that such directive influence was indeed exerted.[607]

Hopkins thus staked his claim to the Nobel Prize for the discovery of vitamins on his influence on the American work that distinguished fat-soluble A from water-soluble B.

Having examined the scientific work that took place in the United States leading up to the distinction of fat-soluble A from water-soluble B, it is quite clear that Hopkins' 1912 paper did not have nearly as much influence on that research as the University of Wisconsin's Single-Grain Experiment. McCollum's inspiration from the Single-Grain Experiment is obvious. In 1921, McCollum wrote a private letter to Babcock: "No one with whom I have ever come in contact has had a more stimulating effect on my mental activities than you have," McCollum wrote, "and I feel I owe a great deal to you."[608] Hopkins' claim to having influenced Osborne and Mendel is also suspect: In a brief survey of Osborne and Mendel's early research on vitamins between 1911 and 1914, their references to Hopkins are infrequent and brief; meanwhile they discuss McCollum's work at the University of Wisconsin in nearly every paper.[609] In a 1912 paper, Osborne and Mendel also discuss the Single Grain Experiment as "splendid study" which "strikingly" showed the "necessity of long continued experiments," describing the nature of the experiment and quoting its conclusion at length.[610] This paper only briefly mentions Hopkins' work.

Though the Single Grain Experiment clearly influenced early research on vitamins in the United States, it is missing from a number of accounts of early vitamin research. Hopkins' Nobel Prize speech notably recognized the work of "McCollum and his co-workers"—not Hart and

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[607] Ibid.

[608] Elmer McCollum to Stephen M. Babcock, November 9, 1921, Babcock papers, Wisconsin Historical Society Archives.

[609] Note that I am not making a priority claim for McCollum and the University of Wisconsin over Osborne and Mendel here; I am noting that Osborne and Mendel seemed to be more in dialogue with McCollum and the University of Wisconsin than with Hopkins. Thomas B. Osborne, Lafayette B. Mendel, and Edna L. Ferry, *Feeding Experiments with Isolated Food-Substances.*, Carnegie Institution of Washington Publication, No. 156 [Pt. I]-II (Washington, D.C: Carnegie institution of Washington, 1911); Thomas B. Osborne, Lafayette B. Mendel, and Edna L. Ferry, "Feeding Experiments with Fat-Free Food Mixtures," *The Journal of Biological Chemistry* 12, no. 1 (1912): 81–89; Thomas B. Osborne, Lafayette B. Mendel, and Edna L. Ferry, "Maintenance Experiments with Isolated Proteins," *The Journal of Biological Chemistry* 13, no. 2 (1912): 233–76; Thomas B. Osborne et al., "The Relation of Growth to the Chemical Constituents of the Diet," *The Journal of Biological Chemistry* 15, no. 2 (1913): 311–26; Thomas B. Osborne and Lafayette B. Mendel, "The Influence of Butter-Fat on Growth," *Experimental Biology and Medicine (Maywood, N.J.)* 11, no. 1 (1913): 14–15; Thomas B. Osborne et al., "The Influence of Cod Liver Oil and Some Other Fats on Growth," *The Journal of Biological Chemistry* 17, no. 3 (1914): 401–8.

[610] Osborne, Mendel, and Ferry, "Maintenance Experiments with Isolated Proteins," 235.

Steenbock—and "Baltimore" – not Madison, despite the fact that McCollum conducted his early experiments on vitamins A and B at the University of Wisconsin. Funk, in listing scientists who might claim the title of "discoverer" of vitamins, did not mention McCollum. McCollum was never nominated for the Nobel Prize, perhaps because of the plagiarism controversy with Steenbock, or because he seemed to have a poor reputation among his colleagues. McCollum, instead, attributed this exclusion to the fact he worked at an agricultural college. "It is not improbable that my agricultural background was to my disadvantage in the eyes of some," he wrote. "At that period many educators looked upon the subject matter of courses taught in colleges of agriculture as of lesser quality than that given in colleges and universities generally."[611] McCollum wrote in his autobiography that he left for Johns Hopkins because the University of Wisconsin was not boosting his scientific reputation and that he needed to leave in order to "find a place among the most successful men of science in America."[612] Hopkins may have recognized Baltimore instead of Madison for this reason: the University of Wisconsin was an agricultural college, not a medical school; the single-grain experimenters were studying animal feeds, not human disease; and they were seen as applied scientists, not pure scientists.[613] McCollum in fact espoused this idea himself. "In the agricultural field experimenters in animal feeding for profit were looked to with respect as sources of information by exceptionally intelligent farmers," he wrote, "but such knowledge was considered by only a few to be of importance in solving problems in human nutrition."[614] This portrayal supports McCollum's priority-claim narrative that he swept in and realized the real implications of the experiment.[615] Yet the scientists at the University of Wisconsin were certainly aware of the significance of their work. The fact that both Hart and Steenbock would continue this research, and produce groundbreaking understandings of vitamin A and vitamin D (discussed in Chapter 5), shows that they were serious researchers.

The Single-Grain Experiment also calls into question a claim that nearly every scientist vying to be the "discoverer of vitamins" made: that until 1911, the calorimetric, fats-proteins-carbohydrates paradigm absolutely dominated scientific thought in nutrition. This claim—that no respectable scientist thought food contained any value outside of their chemically, quantitively measured nutrients until their own "discovery"—supports their priority claim and narrative of individual genius. "No general or widespread belief in the view that an adequate diet must contain indispensable constituents other than adequate calories, a minimum of protein, and a proper mineral supply, could be said to exist till the years 1911-1912," Hopkins stated in his address. "Those years saw the appearance of my own publications."[616] Hopkins explained that the dominance of this paradigm was the reason that earlier work foreshadowing vitamins went unnoticed, that "the minds of the leaders of thought in nutritional science were obsessed by a sense of the overwhelming importance of calorimetric studies with their impressive technique."[617] In his famed 1912 paper, Funk also described this "obsession" with calorimetry, writing that

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[611] McCollum, *From Kansas Farm Boy to Scientist*, 156.
[612] McCollum, 241.
[613] It is also certainly possible that Hopkins does not mention Wisconsin because it brings into question his own influence on McCollum's work.
[614] McCollum, *From Kansas Farm Boy to Scientist*, 157.
[615] This narrative of priority appears elsewhere as well – even Hopkins, in his address, discusses how "Some workers had discovered suggestive facts, but failed to realize their full significance."
[616] Sir Frederick Hopkins, speech at the Nobel Banquet in Stockholm, December 10, 1929.
[617] Sir Frederick Hopkins, speech at the Nobel Banquet in Stockholm, December 10, 1929. Hopkins points out that because calorimetric studies often used natural foods, and took place over a short period, they did not produce results that would make one question their adequacy; it took a change in method to reveal the error.

physiologists studying what he argued were deficiency diseases only saw food through the lens of macronutrients and calories: "The food was up to now valued only by its content in proteins, fats, and carbohydrates, and calories value."[618] McCollum similarly wrote that until 1911, just "a few pioneers in thought and experiment" believed that chemical concepts could not capture the full value of food.[619]

It is certainly the case that among physiological chemists and pure laboratory scientists studying nutrition, the calorimetric paradigm ruled. But this was not the case among agricultural chemists studying nutrition at experiment stations and colleges like the University of Wisconsin, Madison. This raises the question of what historians and historian-scientists have decided counts as nutrition science in telling this history. Even in Hopkins' speech, he alludes to researchers who were questioning the paradigm through experiments on small animals, but dismisses them as "not very quantitative or crucial in their nature" and "at best unimpressive." The results of these studies "appeared to be on a less sound basis."[620] Just as McCollum left Madison for Johns Hopkins for reasons of scientific reputation, Hopkins noted that he left clinical work because he "had to employ [himself] to the laboratory on more academic lines." Yet, it is worth noting that Hopkins himself recognized the issue of the science placing more value on laboratory than clinical/field research. This was in fact the main argument of Hopkin's 1906 speech often only discussed for its vitamin prediction. The speech – titled "The Analyst and the Medical Man"—explained how the "scientific chemist […] has long ceased to be much interested in the animal or the plant." He continued:

> I mean to endeavour to identify and separate unknown substances, with unknown properties, present in complex mixtures.[…] Such work really requires special instincts, and the pure chemist has largely lost them. He is but a poor analyst, as the physiological explorer finds on turning to him for help.[621]

The pure chemist, Hopkins argued here, did not have the skills to identify unknown substances in foods. In his Nobel address, he references this argument: "Inhibitory, moreover," he stated, in discussing the progress to discovering vitamins, "was the odd assumption often to be detected in the writings of leading authorities that to view nutritional needs from the standpoint of energetics was not alone more convenient, but more scientific, and even more philosophical, than to discuss them in terms of the material supply."[622]

Like others claiming priority, the single-grain experimenters also emphasized the dominance of the calorimetric paradigm when Babcock began questioning it. "Dr. Babcock was one of the first to recognize that planning animal rations on the basis of their chemical composition gave unreliable results," wrote McCollum.[623] In lectures decades later, Steenbock similarly explained that "Dr. Babcock had the conception that an animal required other things besides carbohydrates, fats, and proteins and indigestible materials in its diet" well before pioneering vitamin research.[624] Hart similarly explained how the Single Grain Experiment "disclosed the complete inadequacy of the theory of balanced rations as it prevailed at the beginning of this

[618] Funk, "Who Discovered Vitamines?," 363–64.
[619] McCollum, *From Kansas Farm Boy to Scientist*, 157.
[620] Sir Frederick Hopkins, speech at the Nobel Banquet in Stockholm, December 10, 1929.
[621] Hopkins, "The Analyst and the Medical Man," 396.
[622] Sir Frederick Hopkins, speech at the Nobel Banquet in Stockholm, December 10, 1929.
[623] McCollum, *From Kansas Farm Boy to Scientist*, 114.
[624] Harry Steenbock, lecture on December 2, 1925, Steenbock Papers, University of Wisconsin Archives

century." He continued, "Protein and energy were the total concepts of nutrition needs at that time," and the experiment ushered in a new era.[625] In his obituary of Babcock, Hart described how the experiment was "the forerunner of the development at Wisconsin of the newer approach to nutrition and the first experiment, so as far as I know, using the biological method for testing the nutritive value of foodstuffs. It was a new idea and Dr. Babcock was father of it. Others have carried it on."[626] Babcock's major error was that he "left no long list of contributions to scientific literature, for he was as sparing a writer as a speaker," Hart wrote.[627] Babcock was not listed as an author in the Single Grain Experiment publication, though his experiments were recognized as "the real fore-runners of this larger investigation."[628] De Kruif – who clearly frames Babcock as *the* pioneer of modern nutrition research, wrote that Babcock was never after "immortality" as other scientists were.[629] Though Babcock did not publish, the narrative that his colleagues present of his challenging of the calorimetric paradigms mirrors the narratives of others who claimed priority. In his autobiography, after explaining Babcock's challenge to chemical analysis, McCollum wrote that of Voit, Rubner, Atwater, Lusk and Chittenden – the "authorities" in food and nutritional research—none "made any statements which implied that there remained for discovery any new facts of great significance."[630]

Yet, this dissertation has shown that a number of chemists, especially in agricultural colleges and experiment stations in the Midwest and California, believed much "remained for discovery" in nutrition – that Babcock was not alone in questioning the ability of chemical analysis to evaluate food. The narratives of those making a priority claim purport an idea that before Eijkman's chickens or Holst's guinea pigs or Hopkins' mice or McCollum's rats, the calorimetric view of food as simply proteins, fats, carbohydrates, and minerals was the uncontested framework of nutrition science. In the United States, this was simply not the case. Before an understanding of vitamins existed, chemists working at agricultural colleges and experiment stations questioned the paradigm that relied on understanding food through chemical analysis, and thus questioned the health impact of artificial foods. They called for more research to understand "accessory foods," recognized that animal feeds could not be made through artificial means, and, in the case of Babcock, Hart, and later McCollum, created experiments to prove that there was more to food than the calorimetric paradigm let on.

Kuhn writes that a paradigm shift occurs when a large number of people realize that the current framework does not work, rather than from an individual moment of clarity so often narrated by scientists trying to espouse their own genius and claim priority. The shift is a slower and more gradual process of growing skepticism. In the United States, the scientists who were skeptical of the current paradigm were the ones working with farmers to create rationalized feeds, the ones observing human diets in USDA studies and using their observations to question the standards, the ones warning of inability to truly know the health impact of new processed foods and additives in the pure food debates, the ones who were not confined to the laboratory and a reductionist view. If this is the story of the rise and fall of a holistic approach to nutrition science in the mid to far West, the discovery of vitamins might be the most enduring achievement of that

[625] E.B. Hart, "Outstanding Contributions Made in the Field of Chemistry at the Wisconsin Agricultural Experiment Station," Hart papers, University of Wisconsin Archives.
[626] Hart, "Stephen Moulton Babcock: (October 22, 1843–July 2, 1931)," 5.
[627] Hart, 6.
[628] Hart et al., *Physiological Effect on Growth and Reproduction of Rations Balanced from Restricted Sources*, 1911, 203.
[629] De Kruif, *Hunger Fighters*, 296.
[630] McCollum, *From Kansas Farm Boy to Scientist*, 115.

rise, the triumph that demonstrated that the skepticism was justified and led to new scientific discoveries. But it is also the impetus for its fall, as it would lead to new types of methods and funding that would allow for a reductionist approach to eventually dominate the science.

Chapter 4: Mobilizing the Psychology of Diet
Nutrition Science in the U.S. Food Administration during World War I

Between March and October of 1916, as war raged in Europe, American physiologist Alonzo Taylor studied the food conditions in prisoner of war camps throughout Germany. The Great War had led to an unprecedented amount of prisoners of war among the belligerent nations, and for the first time, this captivity was regulated by an international legal framework which stipulated that (among other requirements) prisoners of war be fed using the same standard that the nation used for their troops during peacetime.[631] The conditions of POW camps were monitored by neutral states, and Taylor acted as a "Scientific Observer" for the American Embassy in Berlin before the United States entered the war. In his study, Taylor was surprised to discover that the German government had selected as the leading expert in the Prison Nutrition Office not "one of Germany's many recognized workers in nutrition," but a scientist whose sole focus was animal husbandry. Professor Blackhaus, Taylor wrote, had little knowledge of human physiology and held a view of nutrition "from an older standpoint of energy equivalents," without a consideration for micronutrients such as vitamins. More importantly, Taylor noted, "He was practically unacquainted with the considerable work that had been done on adaptation of the diet, and was devoid of any conception of the psychology of rationing." Without an understanding of human psychology, Blackhaus "attempted to ration prisoners of war exactly as one would feed live stock [*sic*]." Taylor admitted that there were many similarities between human and animal nutrition, but human nutrition required something more. "In rationing human beings, one must not violate the laws derived from the studies of nutrition of animals;" he wrote, "but merely to apply the feeding rules of the stock farm is not sufficient in the feeding of men."[632]

This equivalence of human nutrition with animal nutrition, Taylor argued, was the root of the problems of the prisoner diet which was implemented. The bread was eaten "without butter or conserves," making it a "very poor breakfast and supper."[633] Weak coffee made from substitutes was served without milk or sugar, and the small meat allowance disappeared into thick, tasteless soups. "Men thus fed acquire a positive homesickness for the sight, taste, and touch of meat;" he explained, "they long for the act of mastication of meat."[634] Taylor described how British and French prisoners of war were given a dark, sour bread—much of it made of indigestible materials—that was "revolting in appearance and taste." "The smell of the bread was like the

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[631] The international law guiding the treatment of prisoners of war was the Hague Convention on Land Warfare (1907). For an overview of prisoner of war camps during the First World War, see: Heather Jones, "A Missing Paradigm? Military Captivity and the Prisoner of War, 1914–18," *Immigrants & Minorities* 26, no. 1–2 (March 1, 2008): 19–48; and Heather Jones, *Violence against Prisoners of War in the First World War: Britain, France and Germany, 1914–1920*, Studies in the Social and Cultural History of Modern Warfare (Cambridge: Cambridge University Press, 2011). For work specifically on food in the prisoner of war camps, see: Nadja Durbach, "The Parcel Is Political: The British Government and the Regulation of Food Parcels for Prisoners of War, 1914–1918," *First World War Studies* 9, no. 1 (January 2, 2018): 93–110; Nadja Durbach, "Keeping Kosher in the Camp: Feeding Interned British Jews during the First World War," *Immigrants & Minorities* 38, no. 1–2 (May 3, 2020): 1–26. After the United States entered the war, they sent POWs to Forts McPherson and Oglethorpe in Georgia and Fort Douglas in Utah. See: Mitchel Yockelson, "The War Department: Keeper of Our Nation's Enemy Aliens during World War I," vol. 1, 1998.

[632] Alonzo Englebert Taylor, "The Diet of Prisoners of War in Germany," *Journal of the American Medical Association* 69, no. 19 (1917): 1577.

[633] Ibid., 1578

[634] Ibid., 1579

smell of the sod, ineffable," he wrote.[635] Yet, he also admitted that this was a matter of taste; German prisoners of war in England in fact asked for the black bread instead of the British white bread. The different allied nationalities had different reactions to the foods based on their customs, and Taylor wrote that the few camps that had allowed the prisoners to prepare the food to their liking were much better off. Arguments over food "kept many of the camps in perpetual uproar" primarily because the authorities in these camps failed "to recognize how serious would be the results of a constant forcing of an unsatisfactory diet."[636]

The failure of the food management at POW camps in Germany, Taylor concluded, had nothing to do with the amount of protein, fat, carbohydrates, salts, or calories that were given to the prisoners, and everything to do with the psychology of diet. "The psychology of a diet is made up largely of externalities that, on paper and in fact, are much less important than protein, fat, carbohydrates, vitamins, salt and roughage," Taylor wrote. "But as a matter of experience, taste, palatability and the normal appearance and consistency of foods are of great importance."[637] These externalities were especially important to prisoners of war, who had experienced the "crisis of battle, the terror of capture, the transition of circumstances of living, the depression of patriotism, the gloating of the captor, the abnegation of defeat, the homesickness that becomes a positive nostalgia, the insomnia" which "combine to produce reactions in the nervous system that easily lead to perversions in the physiologic functions."[638] The German experts in human nutrition were well aware of the importance of a varied and attractive ration, Taylor claimed, as they had warned against perpetually serving monotonous soups in their civic kitchens. Yet Germany had chosen to use "a model stock farm" as the basis for the prisoner of war diet: "the men were dieted precisely like domesticated animals."[639] The German management "failed for reasons of psychology."[640]

Alonzo Taylor's concern for food psychology would become a guiding principle of nutrition science in the U.S. Food Administration. After the U.S. declared war in April of 1917, Alonzo Taylor was appointed director of the Division of Research and Utilization of the U.S. Food Administration, which was headed by Herbert Hoover. Working with scientists to provide guidance to the administration on food rationing and food aid, Taylor made the psychology of diet a key component of his division. "The function of the Division of Utilization and Research," Taylor stated for one yearbook, "is the application of the laws of nutrition to the sociology of alimentation…All food conservation means, in the broad sense, rationing of the people, and this rationing must be carried out in accordance with established principles of the physiology and psychology of the diet."[641] Examining the prisoner of war camps, Taylor had concluded:

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[635] Ibid., 1578

[636] Ibid., 1582.

[637] Ibid., 1581.

[638] Ibid., 1581.

[639] Ibid., 1582.

[640] Ibid., 1582.

[641] Memorandum for Miss Eberle (in response to a request for a statement for the yearbook), October 23, 1917, Reel 53, United States Food Administration Records, Box 43, Hoover Institution Library & Archives. (Hereafter, USFA Records, [Box #], Hoover Institution Archives). In a letter to Lafayette Mendel in 1918, Alonzo Taylor also wrote about how Hoover took a scientific approach that included understanding of psychology, sociology, and industry: "Mr. Hoover is trained scientifically; believes in scientific methods; insists upon scientific surveys as a basis of all action, and while intimately conversant with the industrial, distributive and economic factors that are so important in general food control, never loses from his mind the physiology, psychology, and sociology of diet." Margaret Barnett, "The Impact of" Fletcherism" on the Food Policies of Herbert Hoover during World War I," *Bulletin of the History of Medicine* 66, no. 2 (1992): 237.

"Englishmen blunder into mistakes […] Germans reason themselves into mistakes."[642] Taylor was determined that the U.S. Food Administration would not fall into either category in organizing rationing campaigns and food aid. He thus guided the scientists working with the Food Administration in this direction, combining psychological and physiological understandings of diet.

Current scholarship on nutrition science in the U.S. Food Administration does not discuss this interest in food psychology, and instead argues that the Food Administration embodied a chemically reductionist approach to nutrition in consistently urging Americans to ignore taste, pleasure, and dietary customs and think about food as interchangeable chemical components in order to promote rationing.[643] Yet Taylor and other scientists working with the Food Administration consistently defined nutrition in both psychological and physiological terms, and argued that food psychology—taste, custom, and pleasure—could not be overlooked. These scientists were interested in both the impact of food and diet on the psychological health of people, as well as the impact of human psychology on digestion and metabolism. Especially in a time of war, they were aware of the intricate relationship between diet and mental well-being. They discussed the burden endured in changing ones' diet, and the need for food to be appealing. They included taste and pleasure in their guidelines and food categorization, particularly in discussing meat and sugar. In experiments on restrictive diets, they noted the impact on the mental health of subjects. And throughout the war, they assessed how a change in rations might impact the morale of soldiers, workers, or general citizens. Scientists knew that physiological, hyperrational, and reductionist arguments alone would not make a food meet the psychological requirements of diet, and so they studied food psychology alongside physiology.

This interest in human psychology and the desire to leverage it was not limited to the Food Administration during the First World War. Historian David Kennedy has detailed how President Wilson rallied Americans to the war effort through "deliberate mobilization of emotions and ideas." In the United States, Kennedy writes, "the Great War was peculiarly an affair of the mind."[644] At the same time, the development of the field of human psychology paralleled the development of nutrition science in the United States, and just as the war presented nutrition scientists a practical application for their work and a chance to increase their authority as scientific experts, American psychologists expanded their authority during the war through their work in intelligence testing for the U.S. Army.[645] The interest of nutrition scientists in psychology, and the desire to mobilize psychology, was very much in line with the wider war effort.

However, this interest of nutrition scientists in food psychology during the war has been obscured in current scholarship, largely because scholarship on the Food Administration has focused on the work of reformers in propaganda campaigns. Without a doubt, the "Food Will Win the War" campaign marked a pivotal moment in the societal uptake of nutrition science in the United States. Through posters and advertisements, pledges for wheatless and meatless days, grocery store displays, and articles in popular magazines and newspapers, this campaign taught consumers how to substitute rationed foods while connecting diet to patriotism. Words like

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642 Alonzo Englebert Taylor, "The Diet of Prisoners of War in Germany," *Journal of the American Medical Association* 69, no. 19 (1917): 1577.

643 Veit, *Modern Food, Moral Food*; Levenstein, *Revolution at the Table*, 137–47.

644 David M. Kennedy, *Over Here: The First World War and American Society* (Oxford: Oxford University Press, 1982), 38.

645 Daniel J Kevles, "Testing the Army's Intelligence: Psychologists and the Military in World War I," *The Journal of American History* 55, no. 3 (1968): 565–81; Franz Samelson, "World War I Intelligence Testing and the Development of Psychology," *Journal of the History of the Behavioral Sciences* 13, no. 3 (1977): 274–82.

calories, protein, fat, carbohydrates, and vitamins became a part of the American vernacular as citizens increasingly thought about food in terms of combinations of interchangeable nutrients. It is thus not surprising that scholars like Helen Zoe Veit and Harvey Levenstein have focused on this shift, claiming that modern American understandings of diet are rooted in this era.

Rather than looking at the work of scientists in the Food Administration, these scholars have analyzed how the tenets of nutrition science were popularized and taken to extremes by faddists and reformers. In a chapter on science in the Food Administration in her recent monograph, Veit, for example, explicitly focuses on food faddists, reformers, and the experiences of ordinary people rather than the writings of scientists.[646] She convincingly argues that food fads played a vital role in transforming nutrition "from an esoteric subdiscipline into a respected and popular science" during this era, but she goes a step further to claim that there was little difference between nutrition science and food fads: "Before an elementary consensus on nutrition had solidified, it could be very hard to tell the difference between food science and food fads. Sometimes there hardly was any difference."[647] Like other scholars interested in the history of dietary advice, Veit conflates the faddists and scientists largely by pointing out the ways some food faddists—like vegetarians—were "right" while "nutrition scientists were often wrong."[648] Veit claims that food faddists represent the apex of early nutrition science in their hyper-rationalization of food.[649] Veit's key example is the food faddist Herbert Popenoe, who proposed that Americans eat stray cats and dogs during the war. Ignoring culture, tradition, and taste, Popenoe argued that the meat of cats and dogs was chemically equivalent to other types of meat, an argument that, Veit points out, could only be made with the support of nutrition science.[650] This proposal "was not only part of a larger argument that truly modern people should not let factors as illogical as pleasure and tradition guide their dietary choices," she argues. "It was the culmination of that argument."[651] When Popenoe called his critics "less intelligent" and "unscientific," Veit writes, "he was invoking what had become a Progressive truism: that science, not pleasure, was the best arbiter of wise food choices."[652] Veit's work tells us much about how reformers used scientific authority (in Popenoe calling critics "unscientific") and about popular understandings of the science (especially in that some newspapers referred to Popenoe as a "scientist"). Yet, by not including the work of scientists within the Food Administration, Veit's chapter tells us little about what those scientists thought about food fads like Popenoe's.[653]

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[646] The only scientist Veit discusses in detail is Harvey Wiley, and Veit admits that he did not work with the Food Administration. Veit, *Modern Food, Moral Food*, 53.
[647] Veit, 40.
[648] Veit, 45. In arguing that scientists were often wrong, she cites scientists who argued that fruits and vegetables were "nutritionally worthless" (47), that vitamins were "folklorish" (48), and who had an "obsession with digestion" (45). Previous chapters of my dissertation have demonstrated that many scientists in fact for the value of fresh fruits and vegetables, and suspected substances in foods that had not yet been identified. Though many were certainly interested in digestion, it is not clear why this is unscientific.
[649] Veit, 42.
[650] Referencing Levi-Strauss, Veit describes how, during the war, it was only possible for the eating of cats and dogs to be "good to think" because of "the support of scientists, especially Harvey Wiley himself" (53). Though cat and dog meat reportedly tasted bad, Veit writes that "taste seemed like a pathetic excuse when talk of self-sacrifice and duty was at a zenith" (54). Veit, *Modern Food, Moral Food*.
[651] Veit, 39.
[652] Veit, 38.
[653] Veit, 54. I have yet to find a reference to Popenoe's proposal in the archived papers of scientists who worked with the FA, which at least suggests a lack of explicit support. One *Los Angeles Times* article on Popenoe in fact highlights that the scientific community may have had reservations about his proposal. It read: "Local scientists and officials take varying views of the matter. Dr. William O Woodward, health officer of the district, is aghast at the thought of

Interesting as they are, rather than focusing on the work of faddists and reformers, this chapter examines the writings of scientists like Alonzo Taylor, Graham Lusk, and others involved in the Food Administration. Looking at their writings, it is hard to imagine them supporting a food faddist like Popenoe, as his ration would not meet the psychological requirements of most Americans. In contrast, at a conference on army rationing, leading nutrition scientists discussed whether using cornmeal—a much more ordinary food than the meat of stray pets—would be too burdensome of a change for the army camps! These scientists understood that chemistry and physiology were not the only components of diet. "Now anyone who studies the subject of food in its broadest relations soon learns that it is a very much larger subject than the physiology of nutrition," wrote Alonzo Taylor during the war:

> It includes the sociology of nutrition and includes also important relations to the very intricate manifestations of industry in the broadest terms. And he who would attempt to define the reaction of a particular action from a standpoint of its mere physiological relations would commit a very great error.[654]

Veit writes that the "supposedly culture-blind nutritional equivalency was only possible by deemphasizing tradition, habit, and, often, the pleasure of eating itself," but scientists understood that people would not adopt rations on purely physiological arguments, and saw the importance of connecting rations to tradition, habit, and pleasure.[655] It might be for this exact reason – the fact that scientists recognized that it would be a "very great error" to only consider physiology in thinking about diet – that they were so successful in popularizing nutrition science during this era.

I. Rationing to Meet Psychological Requirements

On September 20, 1917, a group of leading nutrition scientists met with the Surgeon General, the Quartermaster of the Army, and the director of the newly established Food Administration in Washington D.C. for a conference on the subsistence of the Army. The passage of the Lever Act in August had made the Food Administration an official entity, with Herbert Hoover—noted for his experience in providing food aid to Belgium—at its head. Soon after, the medical department of the U.S. Army established its own food division, and organized this conference to determine its goals. Food was vital to the war effort, as Europeans faced production shortages, and militaries weaponized food scarcity. The ability to provide food for hungry Europeans and soldiers seemed to be key to victory.[656] The conference had an esteemed attendance, as many of the scientists would later be recognized as pioneers in the field of

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what the Germans would think if they heard that we were reduced to cat meat. John O [*sic*] Mohler, head of the Bureau of Animal Industry, admitted that viewed chemically the flesh of cats undoubtedly contains the elements necessary to sustain life, but that 'as one of the carnivores cats would probably have a very disagreeable taste.'" The *Los Angeles Times* article incorrectly writes that "John O Mohler" was the head of the Bureau of Animal Industry; John R. Mohler was head of the bureau from 1917 to 1943. "Host Feeds Cat Meat to Trusting Guests.: Possible Item Added to War Menu, But Some Are Doubters," *Los Angeles Times,* February 17, 1918.

[654] This quote appears in at least two sources: Speech of Alonzo Taylor, February 8, 1918; "Food for Thought," *The North American* (Philadelphia, PA), April 21, 1918, Folder 3, Reel 53, USFA Records, Box 44, Hoover Institution Archives.

[655] Veit, *Modern Food, Moral Food*, 51. In writing about the popularization of nutrition, Veit and Levenstein analyze the way the Food Administration connected diet to morals and citizenship, but these types of arguments are characterized as being outside of the science itself. Veit, 5.

[656] Veit, *Modern Food, Moral Food*, 12.

nutrition.[657] The goal of the conference was for these leading food experts to provide guidance for creating rations for army camps and cantonments, but the participants commented more generally on the state of nutrition science, the areas of needed research, and the general challenges of creating rations and providing food aid for hungry allies in Europe.

Though one might expect the conference to have been limited to matters of chemistry and physiology in defining the caloric and nutritional needs of the body, consistently the participants discussed the need for rations to meet psychological requirements. "We realize there are very great difficulties attending the discussion of the subsistence of the army," Alonzo Taylor stated in opening the conference, "and the question is both physiological and psychological, it has psychological bearings not only in connection with the soldiers themselves but in connection with the families at home."[658] Conservation depended on "the men responsible for the scientific aspects of the use of food to get a solution…that will…meet the physiological and psychological conditions," affirmed Ray Wilbur, president of Stanford University and then head of the Conservation Division of the Food Administration.[659] On the idea of substituting cornbread for white bread in army cantonments, Carl Alsberg, chief of the Bureau of Chemistry, stated: "I should be a little bit afraid just as a matter of psychology and tactics of issuing an official appeal to the young men going into the cantonments to modify their demands or their diet in the cantonments."[660] Yale physiological chemist Russell Chittenden spoke of the possibility of "realizing fully the value of psychology as well as physiology" in encouraging people to change their habits.[661] Throughout the conference, these scientists were keenly aware of the "matter of psychology," particularly in relation to morale during wartime.[662]

The psychology of diet was especially important because, though the Lever Act gave the Food Administration the power to control prices and enforce rations, rationing remained voluntary throughout the war. Forced rations not only had the potential to hurt morale, but would be particularly difficult to create given the variation of diets across the United States. People in different lines of work had different energy requirements, and on top of individual variation, diets changed from region to region. Wheat consumption, for example, was already low "in certain sections of the country, particularly some sections of the South," Hoover explained. "We have debated the matter oft times," he wrote, "but in view of European experience with voluntary ration,

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[657] The scientists at the conference included: Graham Lusk, Francis Gano Benedict, Lafayette Mendel, Russell Chittenden, Elmer McCollum, Charles Langworthy, Alonzo Taylor –head of the Research Division of the Food Administration—and John Raymond Murlin—the new director of the U.S. Army's Food Division. John R. Murlin would later establish the American Institute of Nutrition and the *Journal of Nutrition* (see dissertation's conclusion).
[658] Report of Conference on the Subsistence of the Army, September 20, 1917, 3, Folder 13 (Report of Conference), Reel 54, USFA Records, Box 44, Hoover Institution Archives.
[659] Ibid., 8.
[660] Ibid., 46.
[661] Russell Chittenden continued (ending with his argument for the low protein diet, as discussed in Chapter 1): "[…]we have got all the psychological aspects to consider and war time is not the time to make experiments, but I do believe that the knowledge of the persons and the experience that has been gained on the other side of the war demonstrates very clearly that it is possible for our people to subsist on a much lower quantity of protean food per day than the average American is disposed to think he must have." Report of Conference on the Subsistence of the Army, September 20, 1917, Folder 13 (Report of Conference), Reel 54, USFA Records, Box 44, Hoover Institution Archives.
[662] On the day of the conference, a biological chemist wrote to Alonzo Taylor asking for advice on whether he should accept a position in Murlin's food division. Taylor responded that the position might allow him to "acquire a new view-point, a new technique, and enlarged grasp upon his science." He emphasized: "We are learning a new thing: the sociology of nutrition, enlarging our previous knowledge of the psychology of nutrition, and learning not a little about the physiology of nutrition." Phillip A. Shaffer to Alonzo Taylor, September 20, 1917; Taylor to Shaffer, USFA Records, Box 186, Reel 243, Folder 8, Hoover Institution Archives.

we have always been driven to the conclusion that short of a forced ration, bread, meat, and fats must be a matter of individual pressure through propaganda and '——less' days and such devices."[663] As rationing was voluntary, a large portion of the Food Administration focused on educating and "pressuring" the public through propaganda. The Publicity Division of the Food Administration mounted a widespread campaign, using traditional media (such as newspapers, periodicals, magazines, trade journals, etc.) as well as moving pictures, posters, train demonstrations, and work in schools, churches, labor organizations, medical societies, hotels, restaurants, grocery stores, and other venues to spread the word of rationing certain foods while maintaining health.[664]

This presented an extraordinary opportunity for nutrition scientists. One attendee at the army conference declared that "here is their opportunity for a great educational propaganda among the public." Though the scientists might not all have "the same gospel," he noted, it was an opportunity to "[press] on the general public sound ideas as to diet, food, and so on."[665] The Food Administration sought to base their rationing campaigns in scientific research, and citizens were newly interested in nutritional information authorized by the government. A meeting of the Advisory Committee on Home Economics discussed how "magazines, newspapers, etc., were for the first time desirous of obtaining official approval of such articles and there was likewise a growing demand for it on the part of the people." This presented a large "opportunity to accustom the public to turning to experts instead of faddists for information along this line and a step toward the control of sources of information."[666] Home economists like Isabel Bevier, the University of Illinois chemist who conducted USDA dietary surveys (Chapters 1 and 3), adopted a role in education in the Food Administration. Bevier wrote of the need for workers in home economics "to interpret […] I am wondering just how much work it will take to get into the minds of people the simple truth that there are five classes of food and three functions of food. The one great problem is to interpret in understandable language." [667] Rather than experts allying with faddists in a quest for rational eating, scientists saw an opportunity during the war to claim authority over faddists. Other sources equally described this shift away from food faddism and popular diets and toward scientific and government expertise in nutrition during the war. "Once again came evidence that the public prefer an 'authorized version,'" stated the minutes of a meeting on the food needs of the poor, "They 'do not want to be told by the newspapers what to eat and what not to eat'."[668] "It seems to me that we have reached a time, not only in this country but really throughout the civilized world," declared Russell Chittenden at the conference for army

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[663] Interoffice Memorandum of the U.S. Food Administration on "Voluntary Rationing Pledge," Herbert Hoover to Sarah Splint, December 14, 1917, Reel 13, Folder 12, USFA Records, Box 9, Hoover Institution Archives.
[664] Publicity Division of the Food Conservation of the Food Administration, August 10, 1917, Reel 14, USFA Records, Box 11, Hoover Institution Archives.
[665] Report of Conference on the Subsistence of the Army, September 20, 1917, Folder 13 (Report of Conference), Reel 54, USFA Records, Box 44, Hoover Institution Archives.
[666] Meeting Minutes of Advisory Committee on Home Economics, July 19, 1917, 4-5, Reel 13, USFA Records, Box 10, Hoover Institution Archives.
[667] "We must be careful to speak in the form of language that the people really understand," she emphasized. "Food and Food Administration" November 14, 1917, Isabel Bevier Papers,1879-1942, 1945-1955, Box 13, University of Illinois, Champaign-Urbana.
[668] "Confidential Meeting on the Food Needs of the Poor," New York City, February 5, 1918, Reel 13, Folder 14, USFA Records, Box 9, Hoover Institution Archives.

subsistence, "where there is an opportunity for the people of the world to gain a just appreciation of the real importance of an understanding of the laws of nutrition and the laws of dietetics."[669]

Seizing this opportunity, the Research Division of the Food Administration collaborated with scientists to provide research-based guidance on rationing at home and food aid abroad. In a document titled "Definition of the necessary elements of nutrition," the Advisory Committee on Alimentation in the Research Division framed nutrition requirements in both physiological and psychological terms. The first part of the document explained that the body needed a certain amount of protein, fat, carbohydrates, the "hypothetical substance known as water-soluble vitamine," salts, and "indigestible materials" in fruits and vegetables, but the second part of the document was devoted to the equal need of understanding the "psychology and function of the war-time control of subsistence of the people."[670] Wartime was not the time to make radical dietary changes, they argued: "no article of diet ought to be suggested that has not be thoroughly tried upon large classes of people at home or abroad, and preferably at home and over a definite period of time."[671] "Experimentation is to be strictly avoided," they proclaimed, "education studiously cultivated."[672] Officials in each region should push constituents towards the "intelligent adaptation" of wartime rations, the committee advised, rather than enforce a standard diet, which would be both psychologically oppressive and inefficient, as it would certainly result in a reaction "against the movement of food conservation." Even in "as homogenous a state as Germany," the attempt to enforce the same diet upon the "inhabitants of Spreewald and the peasants of the Bavarian upland" was a "violation of the consciousness of the individual," the document stated.[673] It concluded: "A principle may be physiological correct and even advantageous and yet psychologically so disadvantageous as to merit rejection."[674]

In *Food in War Time*, Graham Lusk, a physiologist by training and a pioneer in nutrition science, also described how the physiological functions of various nutrients were not the only components of nutrition: "for the food offered must be acceptable to the palate of the individual." Lusk concluded: "The proper nutrition of an individual depends, therefore, not only upon a sufficient supply of food from a mechanistic standpoint, but also upon the reasonable satisfaction of the sense of appetite. These dual fundamentals of proper nutrition should be ever borne in mind."[675] Taylor, Lusk, and other scientists working with the Food Administration defined nutrition in physiological as well as psychological, sociological, and cultural terms.

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[669] Report of Conference on the Subsistence of the Army, September 20, 1917, Folder 13 (Report of Conference), Reel 54, USFA Records, Box 44, Hoover Institution Archives.

[670] "Definition of the necessary elements of nutrition," [no date], Folder 17, Reel 53, USFA Records, Box 43, Hoover Institution Archives.

[671] Ibid.

[672] Ibid. In the conference on the subsistence of the army, Elmer McCollum also described the need "not to encroach upon the field of experiment with human beings in war time, but to take advantage of all we know and feel confident is an established fact" in creating rations. Report of Conference on the Subsistence of the Army, September 20, 1917, Folder 13 (Report of Conference), Reel 54, USFA Records, Box 44, Hoover Institution Archives.

[673] "Definition of the necessary elements of nutrition," [no date], Folder 17, Reel 53, USFA Records, Box 43, Hoover Institution Archives.

[674] Ibid. The understanding of the importance of food psychology for rationing rekindled the need for local dietary surveys. In a letter on August 1, 1917, Taylor wrote: "A great many regional diets were collected up to a few years ago. Then Secretary of Agriculture Wilson was badly advised into discontinuation of this type of investigation. Now they are very badly needed. In the meanwhile, we need to secure wherever we can studies on class or regional diets that have been carried out under proper conditions of control during recent years and of these yours would be very valuable to us." Alonzo Taylor to Professor Voegtlein, U.S. Public Health Service, August 1, 1917, Washington, D.C. Reel 243, Folder 9, USFA Records, Box 186, Hoover Institution Archives.

[675] Graham Lusk, *Food in War Time* (WB Saunders Company, 1918), 23.

While scientists working with the Food Administration recognized the need for rations to meet psychological requirements, they also understood food psychology as somewhat flexible for both soldiers and civilians. "The psychology of the soldier with regard to food will be inversely proportionate to his consciousness of the strain of war in normal conditions," Alonzo Taylor explained in the conference on the subsistence of the army. "In other words, when our soldiers realize that it is really war, they lose their psychology of the ration, but as soon as a man becomes over-worked or is wounded then the psychology of the ration returns in double force."[676] While rations were even more psychologically important to those overburdened by war, the understanding of the seriousness of war could also diminish the psychological requirements of a diet. The Division of Publicity used this second observation of food psychology throughout their campaign, consistently emphasizing the gravity of war. They stated this goal in an early general plan of their department, submitted in August of 1917: "The proper psychological basis had to be prepared for this program," it read, "by indicating the seriousness of the war situation and the need of food by our allies." Only after this "psychological basis" was prepared could they "interest all in food conservation."[677]

II. Wheat: "A psychological though not a physiological deprivation"

The understanding of both the importance of food psychology for morale and the flexibility of psychology and mobilization of emotion is nowhere more apparent than in the campaign for rationing wheat. Wheat was a key component of food aid during the war. Not only had Europe experienced a wheat shortage, but wheat flour was also a dense source of calories with a long shelf life, and thus an efficient food item to ship overseas. The Food Administration encouraged Americans to substitute wheat with other nutritionally equivalent foods like corn, oats, barley and rice. As other scholars have detailed, the administration often drew on the authority of nutrition scientists to encourage Americans to think about foods in terms of interchangeable nutrients in arguing for substitution.[678] One source declared that it was "the unanimous scientific opinion of the committee [on alimentation]" that wheat had no superiority compared to other cereals. "The most authoritative group of scientists," it proclaimed, endorsed mixed grain bread as "just as nourishing […] and in every way […] a normal bread and the majority of individuals will not notice that it is not whole wheat bread."[679] Frequently Food Administration publications referenced "specialists" and scientists to claim that there was "no dietetic difference" between the wheat and other grains.[680] Scientists in the Food Administration insisted "that going without wheat would be a psychological though not a physiological deprivation."[681]

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[676] Report of Conference on the Subsistence of the Army, September 20, 1917, Folder 13 (Report of Conference), Reel 54, USFA Records, Box 44, Hoover Institution Archives.
[677] Publicity Division of the Food Conservation of the Food Administration, August 10, 1917, Reel 14, USFA Records, Box 11, Hoover Institution Archives.
[678] Veit, *Modern Food, Moral Food*, 45.
[679] "Grain aid," 7, Folder 2, Reel 53, USFA Records, Box 44, Hoover Institution Archives.
[680] United State Department of Agriculture, "Food Thrift Series: No. 1," (Washington DC, 1917). Other sources written by scientists emphasize the nutritional equivalence between the grains. See, for example: Remarks by Dr. Taylor, August 22, 1917, Reel 53, USFA Records, Box 43, Hoover Institution Archives.
[681] "Why We Must Send Wheat," U.S. Food Administration Bulletin No. 14 (Washington DC: Government Printing Office): May, 1918. Listed as authors in the bulletin text on page 3: R.H. Chittenden, Graham Lusk, E.V. McCollum, L.B. Mendel, C.L. Alsberg, F. C. [sic] Langworthy, Alonzo Taylor, Vernon Kellogg, Raymond Pearl, Ray Lyman Wilbur.

Though scholars have focused on the physiological part of this statement, the "psychological" part was in fact key to the scientists' arguments for sending wheat to Europe. After all, if the grains were all nutritionally equivalent, some Americans asked, why not ship another grain to allies? "It is a question involving the sociology and psychology of the habits of these people, and has nothing to do with their nutrition at all," Alonzo Taylor answered. "It also involves our sociology and psychology, and does not involve our nutrition at all."[682] On the European side, wheat had psychological importance because the allies were "a bread eating people" who were already burdened with war, and thus, as Taylor described with the soldier's psychology of diet, food customs had increased importance for morale.[683] "It has been the experience of the warring nations that the bread ration should not be too greatly reduced, since it alters the psychology of the diet," the Committee on Alimentation reported.[684] Bread aid was needed maintain "the health and the strength and the morale of the people," Hoover emphasized in another conference.[685] In a war-torn Europe, bread had only increased in psychological importance. "[S]ubstitution will not in any way inconvenience us from the standpoint of nutrition," one article read. "But it will add immeasurably to the fighting strength and the fighting spirit of those who are laying down their lives in order that democracy may not perish from the face of the earth."[686]

By discussing the psychological value of bread abroad, food administrators could also mobilize emotion and emphasize the "seriousness of war," creating the "psychological basis" needed for conservation. In a speech to hotel men titled "Wheat Not Necessary," Taylor stated that the "predilection for wheat is solely a question of taste, comfort and convenience" and "absolutely nothing else," but that it was because wheat "lends itself to habits of ease and convenience" that it should be sent to Europe and "not kept here." He continued: "we ask and expect the American man and woman in judging of every situation as contrasted with that of our Allies, men and women, to ask who has the larger burden to bear, who has borne it the longest, who has wasted resources the most, who has lost most by sacrifice, who has suffered the most in death and destruction, we or our Allies?"[687] Other sources on substitutes detailed the burdens endured abroad, describing how "[t]he men crippled in fighting our battles, the women widowed for our freedom, the children orphaned to make the world safe for future children […] stretch their pitiful hands to us across the seas. We can say: brothers and sisters, every grain of wheat, every particle of flour this country has is yours - YOURS."[688] Confronting Americans with scenes of

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682 Speech of Alonzo Taylor delivered before the War Convention and the National Retail Dry Goods Association at the Hotel Astor, New York, February 8, 1918, Folder 3, Reel 53, USFA Records, Box 44, Hoover Institution Archives. Interestingly, Food Administration scientists often spend more time discussing the psychological and sociological reasons to send wheat rather than the reasons connected to shipping efficiency. This could either be because they thought the shipping reasons were less important, or they thought describing the psychological and sociological reasons would be more convincing/motivating to Americans.
683 "Grain aid," Folder 2, Reel 53, USFA Records, Box 44, Hoover Institution Archives.
684 Ibid.
685 Minutes of Proceedings at a Conference of the Allied Food Controllers, July 23, 1918, Alonzo E. Taylor Papers, USFA Records, Box 4, Folder 9, Hoover Institution Archives.
686 "Food for Thought," *The North American* (Philadelphia, PA), April 21, 1918, Folder 3, Reel 53, USFA Records, Box 44, Hoover Institution Archives. Before this quote, the article reads: "For us to eat less of certain foods now and make larger use of certain other foods is a sociological as well as a physiological matter. Such a change and such substitution…"
687 Alonzo Taylor, "Wheat not necessary," speech to hotel men, March 29, 1918, Folder 2, Reel 53, USFA Records, Box 44, Hoover Institution Archives.
688 "Do You Know Corn Meal?" and "Do you know oatmeal?" Reel 24, Folder 8 (California), USFA Records, Box 20, Hoover Institution Archives. As other scholars have noted, Food Administration propaganda also connected

hardship and loss in war-torn Europe, the Food Administration asked Americans to take on the burden of rationing wheat so Europeans could obtain their daily bread. "Is it worth the effort, when our allies are already so hard pressed," University of Wisconsin chemist and domestic scientist Abby Marlatt asked, "to add to their burden this additional burden of revolutionizing their food habits?"[689]

Yet, scientists working with the Food Administration did not argue that Americans should ignore their own food psychology in order to boost morale abroad.[690] After all, the scientists were also concerned with morale at home. Hoover admitted that bread was of "psychological importance" in the U.S., and stated that he was only willing to provide aid as long as "we are physically able to maintain the strength and maintain the morale of our people."[691] A committee of scientists advised the Food Administration that they only recommended substituting cereals for bread "as an emergency measure" largely because "a sudden break in our custom would have for some people a psychological significance more or less disturbing."[692] Rations had to "conserve the psychology of the diet, by which we mean the natural cuisine, the accustomed taste and appearance of food," Taylor argued. "It is much better to have a diet altered by having more or less of certain things than to introduce new items or dishes." To introduce new items to a diet, such as rice in place of bread, "is to enter upon an unnatural line, to be adopted only in a situation of gravity."[693]

Rather than arguing that Americans should revolutionize their diet so that Europeans would not have to, the scientists argued that, as Marlatt explained, "With us it would not be revolution but extension of use."[694] Americans were psychologically and sociologically more prepared to ration foods not only because of their distance from the burdens of war, but also because rationing would not require a "revolution" in food habits, these scientists argued. This argument drew on two main factors: familiarity with diverse foods and women's labor in cooking and baking. Though wheat possessed "no dietetic qualities that are not possessed by oats, barley, rice, or corn," scientists did distinguish it from other grains in "certain physical properties" that allowed wheat to make a bread that could be easily bought and sold. "The allied people all buy their bread," the Committee on Alimentation explained, "Household baking is practically unknown. This is the most economic and efficient method for them during the war, since the women are engaged in

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rationing to patriotism, democracy, and freedom—themes that appeared throughout war propaganda in the U.S. during this period. Marlatt wrote: "Of our own free will we can send wheat for liberty; out of love for our fellows we can eat potatoes for democracy." Veit has documented this aspect of the war propaganda: Veit, *Modern Food, Moral Food*, 11–36.

[689] Abby Marlatt, "Food Conservation Section," Press Releases, July 1917, Reel 14, USFA Records, Box 11, Hoover Institution Archives.

[690] Cullather discusses how Hoover recognized the importance of bread to morale and how bread shortages were linked to unrest. He wrote that Hoover believed exporting wheat could "leave a morale deficit in the United States that could be filled only by social discipline." Cullather, "The Foreign Policy of the Calorie," 348.

[691] Minutes of Proceedings at a Conference of the Allied Food Controllers, July 23, 1918, Alonzo E. Taylor Papers, USFA Records, [Box 4, Folder 9], Hoover Institution Archives.

[692] Like other scientists, they also argued that understanding the "emergency" of war and need for aid would help reduce "this psychological disturbance." "Why We Must Send Wheat," U.S. Food Administration Bulletin No. 14 (Washington DC: Government Printing Office): May, 1918. The document on "Grain aid" specified that they sought to export wheat with "the least disturbance to the habits of the American people," echoing the advice of this committee. "Grain aid," Folder 2, Reel 53, USFA Records, Box 44, Hoover Institution Archives.

[693] Alonzo Englebert Taylor, "To Reduce the Cost of Eating," *Saturday Evening Post,* March 5, 1921, Alonzo Englebert Taylor Papers, Box 1, Hoover Institution Archives.

[694] Abby Marlatt, "Food Conservation Section," Press Releases, July 1917, Reel 14, USFA Records, Box 11, Hoover Institution Archives.

agricultural work, the manufacture of munitions, and innumerable other forms of labor."[695] The bakeries of Europe, especially of France, were unprepared to make bread from substitutes, other sources explained. American women, on the other hand, largely baked their own bread at home, and thus could be more flexible with using wheat substitutes.[696] Moreover, Alonzo Taylor often emphasized that French women simply did not have time to bake due to the burdens of war, while American women could make this sacrifice. "The 34,000,000 women in this country, of whom only a little more than one-fourth are classed as under gainful occupation, are asked to use other cereals in order that the 20,000,000 women of France, all of whom at present might be classed as hard laborers, may be supplied with enough bread to live on without adding to their burdensome—yes, even galling—duties," he stated.[697] "Who has time to spend on the preparation of cereals," Taylor asked in another speech, "the American women or the women of France?"[698]

The Food Administration argued that American women not only had more time to bake, but that they were already familiar with other types of grain, especially corn.[699] "To us cornmeal is an old and familiar foodstuff," Abby Marlatt stated, "to our allies it is a new and untried food. To us it is a local product made and ground in local mills or even in the hand mill for daily use for our allies, new machinery, new methods and new habits would be necessary in order for them to use it." Marlatt wrote that most Americans even "find [cornmeal's] flavor better," making it easy to substitute the food "through pleasing ourselves."[700] Rather than needing to revolutionize American food habits, which might disturb food psychology, the Food Administration could ask Americans to use an ingredient with which most Americans were already familiar. "Our plentiful use of corn meal, griddle cakes or muffins, rye bread, buckwheat, rice, oatmeal, etc.," a bulletin to the vernacular press read, "will help to feed starving humanity in Europe and will help us to win the war."[701]

This recognition by scientists of the psychological importance of familiar foods and baking techniques places the Food Administration's posters and advertisements in a new context. Though the Food Administration did use nutrition science to argue for substitution, they often also connected substitutes—especially corn—to American traditions. "Americans have almost forgotten some of the best things we knew," read the introduction to a small Food Administration recipe book. "Corn bread is one of them; oaten bread is another. How many times you have said, That's good, why don't we have it oftener?"[702] The F.A. campaigns often defined corn as a truly American food. In an article in the *Scientific Monthly,* nutrition scientist Graham Lusk emphasized that "Indian corn saved our New England ancestors from starvation, and we can in part substitute

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[695] "Grain aid," Folder 2, Reel 53, USFA Records, Box 44, Hoover Institution Archives. The document also explains that fuel (especially coal) is scarce and expensive for home baking.
[696] Abby Marlatt, "Food Conservation Section," Press Releases, July 1917, Reel 14, USFA Records, Box 11, Hoover Institution Archives.
[697] Quoted in "Food for Thought," *The North American* (Philadelphia, PA), April 21, 1918, Folder 3, Reel 53, USFA Records, Box 44, Hoover Institution Archives.
[698] Alonzo Taylor, speech delivered before the War Convention and the National Retail Dry Goods Association at the Hotel Astor, New York, February 8, 1918, Folder 3, Reel 53, USFA Records, Box 44, Hoover Institution Archives.
[699] Taylor commented on the burden of introducing an unfamiliar food to Europe in: "Remarks by Dr. Taylor," August 22, 1917, Reel 53, USFA Records, Box 43, Hoover Institution Archives.
[700] Abby Marlatt, "Food Conservation Section," Press Releases, July 1917, Reel 14, USFA Records, Box 11, Hoover Institution Archives.
[701] Bulletins to the Vernacular Press No. 2 and 3 (Fall 1917), Reel 14, USFA Records, Box 11, Hoover Institution Archives.
[702] "Bread: A Foreword and Three Recipes," Reel 17, Folder 8, USFA Records, Box 13, Hoover Institution Archives.

it for our wheat and send the latter abroad to spare others from starvation."[703] An F.A. poster similarly stated: "Corn saved the pilgrims and fed our pioneers."[704] In fact, many Americans in the southern United States, food administrators consistently repeated, preferred corn to wheat. "Twenty million people in the South have lived for decades on exactly what we are asking the rest of you to do," urged Taylor.[705] Rather than asking Americans to eat a food based solely on its nutritional contents, the Food Administration connected the substitutes to American traditions. "Our grandmothers used to bake it on a board before the open fire," read the introduction to a USFA recipe for cornbread. "You can bake it in your oven."[706]

The Food Administration not only connected substitutes to American traditions, but also recognized that the United States was a place of diverse cuisines. Conferences in major cities on the East Coast on the "Food Needs of the Poor" outlined the rationing accomplishments and requirements of various immigrant groups. For example, one speaker discussed the "the seriousness of any possible shortage of unleavened bread for Passover" noting that "to the Jews that would be nothing short of a calamity." He then suggested shifting wheat distribution to meet this need.[707] "Brown macaroni" – pasta made from whole wheat –"did not appeal" to Italians, they explained, and suggested working with Italian restaurants and possibly introducing "white meal macaroni" (which I assume was pasta made from white corn meal).[708] As Taylor had written about the psychological disturbance of attempting to replace bread with rice, the administrators did not discuss the need for Italian Americans to eat cornbread, but instead trying to create a familiar food from substitutes. The Food Administration also commended immigrant groups with foodways that adhered to food rations. "Among the Lithuanians and other immigrant races rye bread is common," one bulletin read, "Wheat bread is known as 'straw-bread,' and is seldom eaten. In the conservation of wheat, one Lithuanian newspaper claims that this race excels every race in America."[709]

The diversity of foods in the United States also contributed to a flexibility in food psychology. Because of the diverse population, Food Administration scientists could suggest the introduction of a diverse array of foods with which Americans would already be familiar. Food Administration recipes represented a range of choice in the United States, suggesting recipes ranging from tamales to "practical Italian cooking" to "Allied cookery."[710] Administrators discussed the "co-operation from the Japanese in adapting rice to various uses," including the

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[703] Lusk, *Food in War Time*, 10–11.

[704] "Corn saved the Pilgrims and fed our pioneers. Corn will help us feed the world. Eat more corn. Corn meal - hominy grits - samp: the nation's most abundant cereal ... try a wheatless meal to-morrow.", 1917-07, Poster collection, Hoover Institution Archives, https://digitalcollections.hoover.org/objects/35949.

[705] Speech of Alonzo Taylor, February 8, 1918, Folder 3, Reel 53, USFA Records, Box 44, Hoover Institution Archives.

[706] "Do You Know Corn Meal?", Reel 24, Folder 8 (California), USFA Records, Box 20, Hoover Institution Archives.

[707] "Confidential Meeting on the Food Needs of the Poor," New York City, February 5, 1918, Reel 13, Folder 14, USFA Records, Box 9, Hoover Institution Archives.

[708] Ibid.

[709] Bulletins to the Vernacular Press No. 2 and 3 (Fall 1917), Reel 14, USFA Records, Box 11, Hoover Institution Archives. Scientists defined the psychological requirements of diet as connected to culture, tradition, and custom that were sometimes linked to race, and wrote statements like "a certain minimum of bread every white person must have." Alonzo Englebert Taylor, "To Reduce the Cost of Eating," *Saturday Evening Post,* March 5, 1921, Alonzo Englebert Taylor Papers, Box 1, Hoover Institution Archives; "Food for Thought," *The North American* (Philadelphia, PA), April 21, 1918, Folder 3, Reel 53, USFA Records, Box 44, Hoover Institution Archives.

[710] "Bibliography: Recent Material on Food and Nutrition," USFA Home Conservation Division, May 25, 1918, Reel 12, Folder 7, USFA Records, Box 9, Hoover Institution Archives.

development of rice cakes.[711] In the United States, Taylor wrote, reflecting on his work in the Food Administration decades later,

> demands which are elastic are more elastic than in other countries; thus the range of choice and substitution is wider than in Europe. We have in this country fewer ritualistic influences, rare vestiges of superstition, less folklore of custom and tradition - the attitude of mind toward the food supply is more open and experimental.[712]

While wheat might have been a necessity for food psychology in Europe, Taylor and other Food Administration workers claimed that the distance of Americans from war and their exposure to diverse types of food made substitution possible without a psychological disturbance.[713]

III. "No Civilized Man Can Live Without Cooks": The Physiological and Economic Value of Taste and Pleasure

The Food Administration not only placed value on custom and tradition, but also connected rationing to another, related aspect of food psychology: taste. The appearance and flavor of food, scientists during this period argued, had both psychological and physiological importance, as taste and pleasure could impact digestion. "Attractive flavor and texture in food are believed to be of physiological importance," an FA bulletin stated. "A palatable diet tends to stimulate the normal progress of stomach digestion, which is a different matter from thoroughness of digestion."[714] In outlining the "Fundamentals of an Adequate Diet," the Food Administration wrote that though "appearance, flavor, and other things that contribute to the palatability of the diet…may not influence materially the thoroughness of digestion, they do play a part in insuring a regular and normal sequence of digestive processes and are very important to satisfaction and feeling of well-being."[715] Elmer McCollum[716] described how, if a human child is repeatedly subjected to the smell of food without being given food, the stomach will stop producing digestive juices in anticipation: "With resentment, anger and other unpleasant emotions the secretory activity of the entire alimentary tract becomes promptly suspended. […] Fear, pain, anger, and foreboding will tend to interfere with both the secretory activity and the muscular function of the entire alimentary tract." He concluded that the taste of food was essential to proper digestion. "It is of special importance therefore in nutrition that the taking of foods be accompanied by pleasurable

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[711] "Confidential Meeting on the Food Needs of the Poor," New York City, February 5, 1918, Reel 13, Folder 14, USFA Records, Box 9, Hoover Institution Archives.

[712] "The Changing Food Supply" (ca 1940), Alonzo Englebert Taylor Papers, Box 1, Hoover Institution Archives. He similarly wrote of Italy being in a "happy position" when it came to rationing because its population ate bread, rice, and corn. Alonzo Englebert Taylor, "To Reduce the Cost of Eating," *Saturday Evening Post,* March 5, 1921, Alonzo Englebert Taylor Papers, Box 1, Hoover Institution Archives.

[713] Historian Donna Gabaccia has argued that this diversity of cuisine in fact defines the American diet. Donna R. Gabaccia, *We Are What We Eat: Ethnic Food and the Making of Americans* (Harvard University Press, 2009).

[714] United States Food Administration, *Ten Lessons on Food Conservation* (Washington DC: Government Printing Office), August 1, 1917, 29 USFA Records, [Reel 417, Box 317, Folder 3], Hoover Institution Archives.

[715] United States Food Administration, *Ten Lessons on Food Conservation*, 47, USFA Records, [Reel 417, Box 317, Folder 3], Hoover Institution Archives.

[716] Though there is no author listed on the document, "A Primer for Nutrition" is attributed to McCollum in a letter from Lusk to Taylor on July 30, 1917, Reel 242, Folder 6, USFA Records, Box 186, Hoover Institution Archives.

sensations," he argued. "Food should be of pleasing appearance, should give off agreeable odors, and should be appetizing in taste."[717] Pleasure was defined as a vital component of nutrition.[718]

As nutrition scientists in the Food Administration argued that proper cooking was vital to healthy digestion of food, they also argued that it was a valuable component of preventing food waste. The art of preparing food to make it attractive and appetizing thus had a physiological and an economic value. Campaigns against food waste frequently referred to "careless cooking" as a large contributor to waste, partially from cooks wasting in preparation, but also through "bad cooking, burning, and undercooking"[719] or the food being "improperly seasoned, and thus made unpalatable."[720] A USDA series on "Food Thrift" detailed how

> Vegetables properly prepared tempt the appetite. When they are served in soggy form or in watery or poorly flavor dishes, much of them will be left on the table. The nutritive value of meat of fish can be lessened by overcooking or improper cooking. If fats are allowed to burn even a little, they develop unpleasant flavors and usually cause people to refuse gravies and sauces made with them or foods fried in them; burned meat is also disagreeable, as are burned vegetables.[721]

The USDA advised "the housewife" to "use her own skill and labor to make her meals nutritious and attractive" in using cheap foods and leftovers.[722] Before the United States entered the war, Alonzo Taylor wrote of the "wonder of French women" in their efficient use of food in the kitchen. "Exactly therein lies the art that is lacking in this country," he stated.[723] This attack on the cooking skills of American housewives would fade from the propaganda, but at the beginning of the war, Food Administration scientists seemed to have no problem accusing American women of contributing to food waste due to their poor cooking skills.

The argument that culinary skills were economically valuable expanded outside of the kitchens of American women to the army camp kitchens as well. In the Conference on the Subsistence of the Army, the scientists discussed cooking in army camps at length. Nutrition scientist John Murlin urged the conference attendees to bear "in mind that palatability and proper cooking are great factors in determining the economical utilization of food in the physiological,

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[717] "A Primer for Nutrition" Reel 53, USFA Records, Box 43, Hoover Institution Archives., 17.

[718] This is also clear in the promotion of substitutes, though this trend might be viewed simply as propaganda to encourage Americans to eat different foods rather than being an important part of nutrition. Posters and bulletins promoting substitutes often advertised their "pleasing" flavors, and Food Administration workers were instructed to make any displays of food "look palatable and attractive. An unwholesome exhibit of foods is worse than none," the FA warned. Displays for Potato Campaign, Reel 12, Folder 7, USFA Records, Box 9, Hoover Institution Archives. One example of the emphasis on the "pleasing flavor" is in Abby Marlatt's press releases, but statements about the good flavors of substitutes appear throughout the Food Administration's campaigns. Abby Marlatt, "Food Conservation Section," Press Releases, July 1917, Reel 14, USFA Records, Box 11, Hoover Institution Archives. "It must be borne in mind that the food value of corn meal is similar to that of wheat," Marlatt wrote. "As most of us find its flavor better, it will not be hard for use to increase the use of dishes based on corn. In this way we can 'acquire merit' through pleasing ourselves."

[719] Helen Hammel Harlan, *Wheatless-Meatless Meals*, Bulletin of the American School of Home Economics, Approved by US Food Administration (Chicago, IL, March, 1918), USFA Records, [Reel 417, Box 317, Folder 3], Hoover Institution Archives

[720] United State Department of Agriculture, "Food Thrift Series: No. 1," (Washington DC, 1917), 2.

[721] Ibid.

[722] United State Department of Agriculture, "Food Thrift Series: No. 5," (Washington DC, 1917), 6.

[723] Alonzo Taylor, "The Potato is not an Indispensable Foodstuff," [newspaper title missing], February 23, 1917, Folder 1, Reel 53, USFA Records, Box 44, Hoover Institution Archives.

no less than in the financial sense." The conference discussed how the complaints of the cooking in army camps were prolific and contributed to food waste. "In our officers training camps," one conference attendee said, "we have heard from all sides that the problem of cooks and cooking is very, very important." Another attendee agreed that most waste in the army camps could be attributed to the "ineptitude and lack of knowledge of the cooks."

> I think that is the trouble in 99 cases out of a hundred, the waste is the cook, poor results produced by the cook. I think that I have said up in Congress that one of our greatest trouble in this country so far as characteristics of the people is indigestion, I think because we don't know how to cook and we waste any quantity of good material.

Quoting a popular poem from the period, he claimed: "No civilized man can live without cooks."[724] Chemists working with the Food Administration consistently wrote that the flavor and appearance of food were important factors in digestion, waste reduction, the adoption of substitutes, and general well-being.

This understanding of the economic, physiological, and psychological value of taste and pleasure in nutrition made its way into what might seem like the most chemically reductionist component of the Food Administration –the development of dietary guidelines. During the war, the Food Administration produced a series of nutritional guidelines that categorized foods into five groups: fresh fruits and vegetables; meat and meat-substitutes; cereal; sugar; and fat (much like the food pyramids developed later in the twentieth century).[725] The guidelines epitomized the conception of nutrition as interchangeable nutrients and the idea that Americans should turn to nutrition scientists in planning their menus. One pamphlet read that the dietary guidelines allow the American housewife plan "her meals effectively, even though she has no special training in chemistry or dietetics."[726] Other Food Administration documents similarly asserted the need for scientific expertise to guide work in the kitchen, describing how nutritional standards "have been worked out by scientists," and the "matter is so complicated that the ordinary housewife probably has neither the time nor the inclination to make a mathematical calculation of the nourishment her meals afford."[727] These women could use the guidelines to create balanced meals, as "Price, individual preference for certain foods, and even the fact that hunger is satisfied after a meal, are not safe guides."[728] This statement clearly promoted the idea that science should trump culture, tradition, and pleasure in creating a healthful and efficient diet. The guides to dietary requirements certainly support the narrative that the Food Administration promoted a reductionist approach to eating based on established scientific expertise.

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[724] Report of Conference on the Subsistence of the Army, September 20, 1917, Folder 13 (Report of Conference), Reel 54, USFA Records, Box 44, Hoover Institution Archives. 3.

[725] Many documents use these five categories. See, for example: Report of Conference on the Subsistence of the Army, September 20, 1917, Folder 13 (Report of Conference), Reel 54, USFA Records, Box 44, Hoover Institution Archives United State Department of Agriculture, "Food Thrift Series: No. 2," (Washington DC, 1917), USFA Records, [Reel 417, Box 317, Folder 3], Hoover Institution Archives.

[726] United State Department of Agriculture, "Food Thrift Series: No. 2," (Washington DC, 1917), 3, USFA Records, [Reel 417, Box 317, Folder 3], Hoover Institution Archives.

[727] United State Department of Agriculture, "Food Thrift Series: No. 5," (Washington DC, 1917), 6, USFA Records, [Reel 417, Box 317, Folder 3], Hoover Institution Archives.

[728] United State Department of Agriculture, "Food Thrift Series: No. 2," (Washington DC, 1917), 3, USFA Records, [Reel 417, Box 317, Folder 3], Hoover Institution Archives.

Though the guidelines appear to be the epitome of scientific reductionism, scientists also explicitly incorporated taste and palatability into their guidelines, particularly with the categories of sugar and meat. Sugar, like wheat, was a high-calorie and easily transportable food that could be sent to Europe. The European sugar beet industry was decimated by war, causing sugar prices to skyrocket and dwindling domestic supply (Herbert Hoover even expressed concern that the supply of domestic sugar would run out).[729] The Food Administration thus encouraged Americans to limit their consumption. Chemists during this period seemed to agree that physiologically speaking, sugar was not a necessary part of diet, and certainly not in the amounts Americans were consuming it. "Sugar is a modern food luxury," one bulletin read, "a century ago only about a fourth as much was used as now."[730] A document on rationing methods that made the same observation concluded, "we can return to [the past generation's] habits without a loss."[731] A typical Food Administration display placed sugar into piles to compare the average pre-war amount eaten in Europe with that consumed in the United States, visually showing the huge amount Americans ate compared with other parts of the world. "Even if there were no shortage in supply, we as a people consume sugar in enormous amounts," Abby Marlatt wrote, "and as far as our health is concerned, we can get our energy from other foods as completely and as satisfactorily as we can from sugar."[732]

Though scientists in the Food Administration seemed to agree that sugar was not physiologically necessary for a healthful diet, the Food Administration never recommended complete abstinence from sugar, but rather encouraged Americans to use substitutes—like fruit, honey, maple syrup, glucose syrup, and corn syrup—to satisfy their sweet tooth. In fact, despite admitting that it was not a physiological necessity, the Food Administration consistently listed sugar as one of the five major food groups. Though they sometimes wrote that sugar was "an excellent source of body fuel" or a "valuable food" due to its high caloric content, they more often placed value on its "pleasant flavor…which makes the diet more attractive," as one article read.[733] "Unless some of the fuel is in this form the diet is likely to be lacking in flavor," another article on the five food groups stated. "Without a little of fat and sugar, the food would not be rich enough to taste good."[734] Though the food groups depicted foods in terms of interchangeable nutrients, the guidelines clearly did not ignore the importance of taste. The Food Administration recognized that sugar was consumed "largely for the psychological effect of the sweet flavor, which helps make palatable the less highly flavored foods such as cereals."[735] Though the use of sugar could "be defended only on psychological grounds" and "on the ground that its energy becomes available to the body more rapidly than that of the other nutrients," the Food Administration still listed sugar as an important food category.[736] As an article on fat stated: "Our dietary tastes and habits make it difficult to prepare an attractive diet without the use of some fat and sugar."[737]

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[729] Kathleen Mapes, *Sweet Tyranny: Migrant Labor, Industrial Agriculture, and Imperial Politics* (Champaign, IL: University of Illinois Press, 2010), 101.
[730] Harlan, *Wheatless-Meatless Meals*, USFA Records, [Reel 417, Box 317, Folder 3], Hoover Institution Archives.
[731] Rationing Methods, Alonzo E. Taylor Papers, USFA Records, [Box 8, Folder 3], Hoover Institution Archives.
[732] Abby Marlatt, "Food Conservation Section," Press Releases, July 1917, Reel 14, USFA Records, Box 11, Hoover Institution Archives.
[733] United State Department of Agriculture, "Food Thrift Series: No. 5," (Washington DC, 1917)
[734] United State Department of Agriculture, "Food Thrift Series: No. 5," (Washington DC, 1917)
[735] United States Food Administration, *Ten Lessons on Food Conservation* (Washington DC: Government Printing Office), August 1, 1917, 30, USFA Records, [Reel 417, Box 317, Folder 3], Hoover Institution Archives.
[736] Ibid.
[737]Ibid.

This understanding of the psychological value of sugar is apparent in the fact that the dietary guidelines suggested substitutes for sugar, rather than simply not including sugar as a food category. Glucose—a food that a number of chemists had associated with oleomargarine as an artificial, "imitation food" earlier in the century—was promoted during the war, including by scientists. University of California chemist Agnes Fay Morgan worked on glucose syrups, and the Bureau of Chemistry worked with soda manufacturers in using glucose syrups as well.[738] The government even considered endorsing the use of saccharin—a substance that the previous director of the Bureau of Chemistry, Harvey Wiley, had vehemently opposed—but they still held the position that "it may be deleterious to health" and "is liable to impair digestion."[739] Rather than simply arguing for Americans to stop eating foods with added sugars, scientists worked to find replacements.

The Food Administration presented a similar argument with the food category of meat. Rather than rationing meat to send it overseas, meat was largely rationed because meat-raising – especially pork-raising—was an inefficient use of grain. Grain like corn was more effectively used as human food, and so the FA encouraged Americans to substitute other protein sources, such as fish, poultry, eggs, milk, cheese, and legumes for meat. Leading nutrition scientists during this era often argued that meat was not a necessary component of the diet. Though scientists sometimes pointed to the value of meat as a "complete type of protein,"[740] they also described how "Many thousands of vegetarians seem to get along comfortably without meat, and claim better health by doing so."[741] Scientists in the Interallied Commission on Food Science, including Graham Lusk and Russell Chittenden, agreed that "no physiological need exists for meat, since the proteins of meat can be replaced by proteins of animal origin, such as those contained in milk, cheese and eggs, as well as by proteins of vegetable origin."[742] McCollum made the same argument at the Conference for the Subsistence of the Army. Though people were inclined to "inexcusable degree" to "attribute special properties to meat which would make it a food stuff which promotes well being," he stated,

> We do not need meat. We have the experience of a relatively large proportion of the population in certain parts of the world and in this country among those who do practice more or less nearly a strict vegetarian diet all the available experience that has good sound value.

He explained that examinations of meat and the "scientific knowledge of nutrition" supports the belief that "meat has no greater nutritive value than the cereal grains."[743]

"I doubt if anyone today believes that meat is essential food," Carl Alsberg, head of the Bureau of Chemistry, said in response to McCollum, "but a great many people take the position

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738 "Advise Women to Cease Using Sugar," *Madera Mercury,* December 14, 1917, California Digital Newspaper Collection; Official Food Bulletin, June 15, 1918, Reel 24, Folder 8 (California), United States. Food Administration records, Box 20, Hoover Institution Archives.
739 Carl L. Alsberg to Lewis Strauss, September 29, 1917, USFA Records, [Reel 114, Box 91, Folder 14], Hoover Institution Archives.
740 United States Food Administration, *Ten Lessons on Food Conservation* (Washington DC: Government Printing Office), August 1, 1917, 25, USFA Records, [Reel 417, Box 317, Folder 3], Hoover Institution Archives.
741 Harlan, *Wheatless-Meatless Meals*, USFA Records, [Reel 417, Box 317, Folder 3], Hoover Institution Archives.
742 Letter from Chittenden and Lusk to Herbert Hoover, Rome, May 10, 1918, Folder 3-1, Alonzo Englebert Taylor Papers, Box 3, Hoover Institution Archives.
743 Report of Conference on the Subsistence of the Army, September 20, 1917, Folder 13 (Report of Conference), Reel 54, USFA Records, Box 44, Hoover Institution Archives.

that is has more value as food." Though he admitted that he did not agree with this view, he said they needed to speak to "both sides of the question" of meat: "It is the easiest food that you can use to make a ration palatable, because meat cookery is more likely to be a success, it is hard to spoil meat unless you burn it up."[744] Meat was not a physiological requirement, scientists agreed, but they did not discount the value of meat in taste. In writings on food conservation, they wrote that, though meat was not necessary, it was also not unhealthy, "shown by the diet of races living almost exclusively on meat." Even while promoting reduced consumption and "meatless" days, food conservationists did not often argue for the complete elimination of meat from the diet. "Meats…have a peculiar quality which makes them of great importance as a regular constituent of the diet," one bulletin argued. "This is their great palatability."[745] Graham Lusk argued that meat represented a "luxury and waste," but he admitted that "the flavor of meat is such that it lends itself to the easy preparation of a palatable meal," before suggesting that Americans could still obtain this flavoring while cutting their meat consumption in half.[746] Though legumes could be a nutritional substitute, another bulletin stated, they were inadequate because they had "none of the pleasing and characteristic flavor of meats."[747] Food Administration workers believed that "the proper course of digestion of food depends in great measure upon the pleasurable sensations which accompany eating and which we do not experience unless we eat tasty foods, and meats add to the flavor of food."[748] Meat and sugar were important to the diet because they made the diet attractive and palatable, scientists argued, which in turn influenced the physiology of digestion and the ability to avoid food waste. Taste and pleasure were not ignored by scientists creating dietary guidelines; in fact, they were an important component of the guidelines.

IV. "Hunger Breeds Madness": Psychology, Restrictive Diets, and Radicalism

The psychology of diet became particularly important in examining restrictive diets during this era due to the rise of radical movements that seemed to stem from hunger. Americans were well aware of the connection between food and radicalism. Of the Russian Revolution of 1917, Hoover wrote that it was a "bitter experience constantly in the forefront of our minds."[749] There seems to have been a general belief during this time that, as one Food Administration poster read, "Hunger Breeds Madness."[750] Food thus rose as a tool to relax radical fervor and provide political stability. "Each normality in life represents a positive force of value," Alonzo Taylor warned just after the war ended, "And the normality of the diet must not be underestimated as a social factor."[751]

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[744] Report of Conference on the Subsistence of the Army, September 20, 1917, Folder 13 (Report of Conference), Reel 54, USFA Records, Box 44, Hoover Institution Archives.
[745] United States Food Administration, *Ten Lessons on Food Conservation* (Washington DC: Government Printing Office), August 1, 1917, 53, USFA Records, [Reel 417, Box 317, Folder 3], Hoover Institution Archives.
[746] Lusk, *Food in War Time*, 18.
[747] United States Food Administration, *Ten Lessons on Food Conservation*, 51, USFA Records, [Reel 417, Box 317, Folder 3], Hoover Institution Archives.
[748] United States Food Administration, *Ten Lessons on Food Conservation* (Washington DC: Government Printing Office), August 1, 1917, 53, USFA Records, [Reel 417, Box 317, Folder 3], Hoover Institution Archives.
[749] Quoted in: Barnett, "The Impact of 'Fletcherism,'" 252.
[750] Emil Grebs, "Hunger Breeds Madness," poster, 1914/1919[?], Poster Collection, Hoover Institution Library and Archives.
[751] Alonzo Englebert Taylor, "To Reduce the Cost of Eating," *Saturday Evening Post,* March 5, 1921, Alonzo Englebert Taylor Papers, Box 1, Hoover Institution Archives.

At the same time that concerns over radical movements increased, there was also an interest in the possibility to reduce caloric standards amidst shortages, blockades, and observations of war conditions. When Taylor was in Germany during the blockade beginning in June of 1916, he observed that Germans were able to subsist on fewer calories than he expected based on established caloric standards. Taylor's observations prompted a number of researchers in the United States—particularly those in the tradition of "pure" laboratory research in the Northeast—and abroad to conduct experiments on restrictive diets, including Francis Gano Benedict.[752] In his introduction to *Human Vitality and Efficiency Under Prolonged Restricted Diet*, Benedict described how the information that Taylor provided on the blockade seemed to show that the reductions in diet were "not only possible, but are not necessarily cataclysmic. They therefore challenge the scientific world for explanation."[753] Food conservation in the United States had focused on substitutes, but given the war situation, Benedict wondered about the possibility of a reduction in diet. He explained that though his laboratory usually did not conduct research for "economic or sociological purposes," this question was of special importance "from the standpoints of patriotism, economy, and physiology." [754] Breaking from his usual work in the laboratory, Benedict in fact incorporated food psychology into his research methods and findings for this study. He concluded that though the restrictive diet was possible, it caused "the appearance of mental and physical unrest"—particularly in that the subjects became noticeably irritable—and thus it was difficult to argue that a reduction in calories was optimal.[755]

In Spring of 1918, the question of the importance of food psychology and the ability to reduce caloric standards came to a head at the meetings of the Interallied Scientific Commission on Food, which was formed at an interallied conference in Paris in November of 1917. The goal of the commission was to combine the food resources of the allied countries and distribute them equitably with "proper regard to the facts on physiology and political economy."[756] Two physiologists from each of the four allied countries (England, France, Italy, and the United States) served as delegates to the commission to ensure that provisioning was carried out on a "sound scientific basis."[757] Both propaganda on food production and use as well as actual food aid would thus be "organized by men of science well acquainted with the subject."[758] Some articles claimed that this use of science would prevent bias from interfering with fair distribution. "For the first time it will be possible for the interallied pooling of resources and supplies to be carried out equitably in accordance with the impartial decisions of science," praised *The British Medical Journal*.[759]

Yet even before the first meeting of the commission in Paris in March of 1918, the delegates disagreed on the caloric requirements of man and the importance of psychology, and these disagreements aligned with their particular political motives. Though they were allied in the

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752 Note that the Food Administration did not fund or direct research itself. As Dr. Raymond Pearl stated: "The Food Administration has felt that its business is administration and not research at this time, and that when problems come up on the administrative side for which the data were not at hand that they could call on some other organizations outside." Report of Conference on the Subsistence of the Army, September 20, 1917, Folder 13 (Report of Conference), Reel 54, USFA Records, Box 44, Hoover Institution Archives.

753 Francis Gano Benedict, *Human Vitality and Efficiency under Prolonged Restricted Diet*, Carnegie Institution of Washington. Publication, No. 280 (Washington: Carnegie institution of Washington, 1919), 4.

754 Benedict, 4.

755 Benedict, 701.

756 "The Interallied Scientific Food Commission." *Science* 47, no. 1219 (1918): 456.

757 "The Inter-Allied Scientific Food Commission." *The British Medical Journal* 1, no. 2998 (1918): 675.

758 "The Inter-Allied Scientific Food Commission." *The British Medical Journal* 1, no. 2998 (1918): 675.

759 "Inter-Allied Scientific Food Commission." *The British Medical Journal* 1, no. 2999 (1918): 705.

war effort, the countries differed in their relation to food distribution, with the United States in the unique position as the main provider of food aid. As much as Hoover emphasized that the allies were "dining at a common table with a common cause," the American delegates—Graham Lusk and Russell Chittenden, both physiological chemists from the Northeast—were invested in minimizing the set caloric standard, thus minimizing the food aid the U.S. would need to supply.[760] Lusk and Chittenden traveled to England a few weeks before the first meeting of the Interallied Commission with the explicit purpose of "promulgating as widely as possible the general idea of food restriction in harmony with true physiological needs of the body."[761] Chittenden—called "the apostle of moderation in food in the United States"—was selected as an American delegate largely because his experiments promoted a low-calorie and low-protein diet.[762] He later described his purpose in the Interallied Commission as to "impress…on them the absolute necessity of greater economy in the use of food, and even more important to convert them…to the view that restrictions in diet could be borne without danger to health or efficiency."[763] Graham Lusk, also reflecting on this goal later, was aware that it would put them at odds with the other delegates: "Our mission was in part to endeavor to reduce the food demanded of the United States to a minimum," he wrote, "and it could not therefore become highly popular."[764]

The debates over low-calorie diets became quite heated. Lusk and Chittenden described being met with "antagonism to any plan of restriction beyond their present intake of food."[765] This antagonism began when Lusk presented a paper to the Royal Society that claimed that caloric intake could be reduced without harm to health, citing several studies including Benedict's study of restrictive diets, Chittenden's studies on soldiers, and Taylor's observations of German civilians.[766] Members of the Royal Society "showed considerable irritation with regard to the general trend of [his] paper."[767] Ernest Starling, one of the English delegates to the Interallied Food Commission, accused Chittenden of being "very anxious that his experiments be carried out on a large scale" in his arguments for reducing rations, and made this accusation again at the first meeting of the Interallied Commission, where the discussion of a reduced ration was also "exceedingly vigorous."[768] English delegates claimed that the American studies were not applicable in the real world and limited by their laboratory approach. "Even from the narrow point of view of the laboratory," members of the Royal Society argued, the data on low-calorie diets

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760 "Inter-Allied Food Control." *The British Medical Journal* 2, no. 3010 (1918): 263.

761 Graham Lusk and Russell Chittenden to Herbert Hoover, March 9, 1918, Alonzo Englebert Taylor Papers, Box 2, Hoover Institution Archives. They wrote of this goal consistently in their weekly letters to Hoover. For example, in their letter on March 16, they said that in their meetings they "did what they could to impress …with the possibilities of lowered nutrition in case of need." Graham Lusk and Russell Chittenden to Herbert Hoover, March 16, 1918, Alonzo Englebert Taylor Papers, Box 2, Hoover Institution Archives.

762 Lafayette B. Mendel, "The Outlook in the Science of Nutrition." *Science* 78, no. 2024 (1933), 318.

763 Quoted in: Barnett, "The Impact of "Fletcherism" on the Food Policies of Herbert Hoover during World War I," 250.

764 Graham Lusk, "Memories of the Food Situation in 1918," in *Essays and Studies in Honor of Margaret Barclay Wilson: Teacher, Physician, Librarian, Author* (Columbia University Press, 1922), 67.

765 Graham Lusk and Russell Chittenden to Herbert Hoover, March 25, 1918, Alonzo Englebert Taylor Papers, Box 2, Hoover Institution Archives.

766 "Informal Conference: March 20, 1918. Prepared by the Royal Society and submitted to Professors Chittenden and Lusk," March 26, 1918, Alonzo E. Taylor Papers, USFA Records, [Box 4, Folder 6],Hoover Institution Archives.

767 Graham Lusk and Russell Chittenden to Herbert Hoover, March 16, 1918, Alonzo Englebert Taylor Papers, Box 2, Hoover Institution Archives.

768 Graham Lusk and Russell Chittenden to Herbert Hoover, April, 1918, Alonzo Englebert Taylor Papers, Box 2, Hoover Institution Archives.

> cannot yet be considered as fully established. Even assuming accuracy of the conclusions, the conditions under which they were obtained would need rigorous analysis to determine how far for instance they are likely to be fulfilled in the case of families with low purchasing power, or in that of a nation whose diet is arranged neither by the physiologist nor by natural appetite but by the local and general conditions or supply and distribution.[769]

A member of the Royal Society described Lusk and Chittenden as "purely laboratory men quite innocent of all considerations of the effect of such a diet upon the temper of the working classes."[770]

From the narrow view of the laboratory, the Americans missed the importance of food psychology, the English scientists argued. "Whatever precautions Benedict may have employed it is certain that the psychological bias will be against the success of an attempt to reduce the diet of munition workers or soldiers and this alone would condemn the attempt to failure," they stated [their emphasis]. "Failure in production or in high spirit would be fatal in the present crisis."[771] A reduction in rations, the members of the Royal Society argued, would threaten both "industrial efficiency and political stability."[772] Consistently the British scientists stated their fear that a reduced ration might lead to social unrest. The French and Italian delegates took the side of the British, agreeing that though experiments like Benedict's were valuable from "a purely scientific standpoint […] they were not applicable to the present day."[773]

The question of whether the Interallied Scientific Food Commission should consider psychology in their recommendations was contentious, even among the British delegates. When a French delegate – Professor Richet – insisted that rations "must be considered from the scientific as well as from the psychological standpoint," Professor Starling changed course and argued that "it was necessary to lay down rules which were physiological and not attempt to deal with the practical questions." But when Lusk proposed a reduced ration based on scientific experiments, "Starling changed his point of view with regard to the discussion of the subject from a purely scientific standpoint." Instead, he

> laid great stress upon the psychological side of the question and stated that we must not go before our Governments with a statement that such a lowering of the ration as a 10 per cent reduction, is desirable, on the ground that the people would revolt and there would be an industrial crisis and the nation might be compelled to make peace long before the conditions were ripe for such a movement.[774]

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[769] "Informal Conference: March 20, 1918. Prepared by the Royal Society and submitted to Professors Chittenden and Lusk," March 26, 1918, Alonzo E. Taylor Papers, USFA Records, [Box 4, Folder 6], Hoover Institution Archives.
[770] A.D. Hall to Sir William Ashley, 14 March 1918, Ashley Papers, British Library, London. Quoted in: Barnett, "The Impact of 'Fletcherism,'" 251.
[771] "Informal Conference: March 20, 1918. Prepared by the Royal Society and submitted to Professors Chittenden and Lusk," March 26, 1918, Alonzo E. Taylor Papers, USFA Records, [Box 4, Folder 6], Hoover Institution Archives.
[772] "Informal Conference: March 20, 1918. Prepared by the Royal Society and submitted to Professors Chittenden and Lusk," March 26, 1918, Alonzo E. Taylor Papers, USFA Records, [Box 4, Folder 6], Hoover Institution Archives.
[773] Quoting Professor Gley of France. Graham Lusk and Russell Chittenden to Herbert Hoover, April, 1918, Alonzo Englebert Taylor Papers, Box 2, Hoover Institution Archives.
[774] Graham Lusk and Russell Chittenden to Herbert Hoover, April, 1918, Alonzo Englebert Taylor Papers, Box 2, Hoover Institution Archives.

In the end, the British did not impose a bread ration, and the commission decided to maintain the caloric standard, with an added statement that if necessary, the ration could be reduced by ten percent "without injury."[775] After the third meeting of the commission, Lusk and Chittenden noted: "It was interesting to observe how national prejudice and national jealousy creeps even into a Commission such as ours…[Starling]…while a good scientific man, is also a good deal of politician."[776]

Yet it is clear that the American delegates had equally political motives in arguing for a separation of physiology and psychology in the meetings. As this chapter has demonstrated, scientists in the Food Administration recognized the psychological importance of food rationing throughout the war, so their disregard for food psychology during these debates appears to be politically, rather than scientifically, motivated. In discussing the debates, Margaret Barnett points out that "Hoover himself was particularly sensitive to the psychological importance of providing the right sort of food for a particular population," and thus it was uncharacteristic for him to argue for a purely physiological approach.[777] Though Chittenden unceasingly expressed a belief that food psychology was solely a barrier to adopting a more healthful low-calorie and low-protein diet (as noted at the end of Chapter 1), Lusk actually disagreed with Chittenden's arguments outside of the interallied meetings and debates.[778] Reflecting on the meetings in 1922, Lusk wrote, "The whole British attitude was one of reason and common sense."[779] Other contemporary American nutrition scientists—including Lafayette Mendel, Vernon Kellogg, and Alonzo Taylor—also criticized Chittenden's claims. Barnett describes how in *The Food Problem*, Vernon Kellogg and Alonzo Taylor "actually ridiculed 'extremists' in the science of dietetics, singling out 'a small professor in summer, balancing his ration and 'fletcherizing' his food, and with slight exercise of body and brain' who said he could exist on 1500 utilized calories. The professor could only have been Chittenden."[780] But during the debates, all of the American scientists involved supported the reduced rations and the purely physiological approach. Taylor even changed his position on his observations of German rationing when responding to Ernest Starling's criticisms, writing that the reason "why the German nation is both relatively and absolutely more successful in military operations […] is that they have reduced the standard of life and thus increased to the maximum the percentage of work, fuel, transportation and administrative energy to the military program."[781] This was quite a break from his earlier argument that "Germans reason themselves into

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[775] Lusk and Chittenden reflected: "We feel that while we did not obtain all that we desired, we have started the Commission in the direction of serious thought regarding the safety of a reduced ration." Graham Lusk and Russell Chittenden to Herbert Hoover, April, 1918, Alonzo Englebert Taylor Papers, Box 2, Hoover Institution Archives.

[776] Graham Lusk and Russell Chittenden to Herbert Hoover, May 10, 1918, Alonzo Englebert Taylor Papers, Box 3, Hoover Institution Archives.

[777] Barnett, "The Impact of 'Fletcherism,'" 258.

[778] Margaret Barnett points out that Lusk used Atwater calorie standards in his guidelines, and later criticized Chittenden's experiments in his own publications. Barnett, 251, footnote 67.

[779] Graham Lusk, "Memories of the Food Situation in 1918," in *Essays and Studies in Honor of Margaret Barclay Wilson: Teacher, Physician, Librarian, Author* (Columbia University Press, 1922), 68. Lusk also demonstrated his understanding of the importance of food psychology in restrictive diets in his *Food in War Time*, writing that: "The amusing little book entitled 'Eat and Grow Thin' recommends a high protein and almost carbohydrate-free diet for the accomplishment of this purpose, but its advice has made so many of my friends so utterly miserable that I am sure in the end it will counteract its own message." Graham Lusk, *Food in War Time* (WB Saunders Company, 1918), 40.

[780] Barnett, "The Impact of 'Fletcherism,'" 257.

[781] Alonzo Taylor to Ernest Starling, June 5, 1918, Folder 3-1, Alonzo Englebert Taylor Papers, Box 3, Hoover Institution Archives.

mistakes."[782] Scientists were well aware of how politics influenced these discussions. Reflecting on the use of science for political purposes, Francis Gano Benedict wrote to Lafayette Mendel: "abstract science and propaganda are more or less incompatible."[783]

The separation of food psychology and physiology in the interallied meetings reveals how political motives shaped scientific arguments. Though Lusk made purely physiological arguments during the meetings, he later expressed his belief in the importance of food psychology. He wrote that Americans may think the English are selfish in their request for food aid while refusing to eat corn, but "it really belongs in the category of national psychology towards food" rather than selfishness.

> Mr. Hoover could not induce starving Belgians to eat rice. A Frenchmen [sic] would die rather than eat oatmeal. The Italian thrives on corn in the form of polenta. The Englishman is devoted to his Yorkshire hog, whereas the Italian is happy only when surfeited with rice or macaroni […] Appreciation of people living in a foreign land comes through contact with them, through knowledge of their conventions, and not through an application of one's own standards to them.[784]

Later, during the Second World War, Hoover continued to stress the importance of food psychology. "I am quite sure that psychological satisfaction of the diet is more to be urged under [the] circumstances," he argued, "than attempting to give a physiological basis for each component of the diet."[785]

Conclusion

At the last meeting of the Interallied Food Commission, the delegates agreed that each country should establish a national laboratory for human nutrition.[786] In an article arguing for the establishment of a national laboratory in the United States, Lusk listed "a vast field in the study of the psychology of food" as one of the lines of research the laboratory should undertake: "The Jews are told as children that pork is unfit for food, and they rarely conquer their repugnance to it," he wrote. "The English are told as children that maize is food for pigs, and though Americans eat maize bread with pleasure and have recently done so to a huge extent to make possible exports of wheat to Europe the English persist in their unfounded prejudice against it." He then described how a diabetic student, misunderstanding one of his lectures, thought a certain food would treat his condition. The student began to feel better and even look stronger, despite the fact that this food had no physiological effect on his illness. "In this little story lies the essence of much sincere self-deception," wrote Lusk, "as well as the foundation of dangerous frauds which are exploited by the makers of patent medicine." While food psychology might be composed of "unfounded

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782 Alonzo Englebert Taylor, "The Diet of Prisoners of War in Germany," *Journal of the American Medical Association* 69, no. 19 (1917): 1577.
783 Quoted in: Barnett, "The Impact of 'Fletcherism,'" 259.
784 Lusk also described making this point during the discussions with the Royal Society, when scientists suggested that Midwesterners ration corn: "We were able to point out that it would be as ludicrous to ration corn in the Middle West as it would be to ration the fish of the sea upon which the British were so largely depending for animal food." Graham Lusk, "Memories of the Food Situation in 1918," in *Essays and Studies in Honor of Margaret Barclay Wilson: Teacher, Physician, Librarian, Author* (Columbia University Press, 1922), 66-67.
785 Quoted in: Barnett, "The Impact of 'Fletcherism,'" 258.
786 Russell Chittenden and Graham Lusk to Herbert Hoover, London, June 15, 1918, Folder 3-1, Alonzo Englebert Taylor Papers, Box 3, Hoover Institution Archives.

prejudices," Lusk pointed out that it could have powerful effects on individuals, forming feelings of illness or of strength, effects that could also be manipulated for profit.

Nutrition scientists in the Food Administrations were attentive to the importance of food psychology, even as reformers increasingly argued for science and physiology to trump pleasure, taste, and tradition. The separation of food psychology and physiology was certainly something faddists and reformers pushed for during the war, as other scholars have recognized. Arguments that people had "imaginary or baseless" prejudices, and that a person who insisted on maintaining customary food habits was "either ignorant and unwilling to be enlightened or [was] a selfish slacker" appeared frequently in the Food Administration's propaganda. One reformer stated, "We make no sacrifice whatever, but that of habit, taste, our appetite, all purely psychological and not physiological and under these extraordinary and abnormal conditions can we not do our utmost to merely change those habits for the country to which we owe our all!"[787] During the war, reformers certainly popularized the idea that science should triumph over taste, pleasure, and tradition in food choices, even as scientists highlighted the importance of food psychology to nutritional health.

As this separation of psychology from nutrition science would become a hallmark of the science in the twentieth century, it raises the question of how social trends—or changes in American food psychology—may have impacted the direction of the science. During the war, nutrition scientists challenged the reductionist arguments of faddists and recognized the importance of food psychology in creating rations, to mental well-being, to digestion, to food economy and conservation, and to social and political stability. At the same time, they often portrayed psychology as something that could be manipulated to encourage food conservation and substitution. It is possible that the social uptake of the science in wartime changed American food psychology. Indeed, some scholars have suggested that today, the popularization of nutrition science has made nutrients "good to think with"—in other words, it has made it so that nutritional claims can make a food psychologically attractive.[788] As Helen Zoe Veit has closely chronicled, faddists and reformers used scientific concepts of nutritional equivalency to frame previously unappealing foods—or even taboo foods—as "good to think with."[789] This chapter suggests that that narrative may tell us more about the dynamic connection between social deliberation and science than about the ideas of scientists in their laboratories and professional meetings. It does not appear that the war prompted a reductionist vision of nutrition among scientists—in fact, it seems as though the war had an opposite effect, as scientists highlighted the importance of psychology in rationing. As we will see in the next chapter, however, food manufacturers noted a change in American food psychology, and began to see investment in nutrition research and food engineering as a worthy use of resources. The next chapter suggests that the shift of nutrition science towards a narrower focus on individual nutrients—and away from psychological and sociological components of diet—might be rooted in a turn to food engineering and partnerships with food manufacturers.

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787 "Fixed Habits Only Endangered," *The Daily Bulletin* [unknown place], June 4, 1918, Folder 10, Reel 54, USFA Records, Box 44, Hoover Institution Archives.

788 Jesús Contreras Hernández and Joan Ribas Serra, "Are Nutrients Also Good to Think?," *Semiotica* 2016, no. 211 (2016): 139–63. This is a reference to anthropologist Claude Levi-Strauss's idea that food needs to be "good to think with" to be "good to eat."

789 Veit, *Modern Food, Moral Food*, 53, 54.

Chapter 5: Selling the Soul of Nutrition Science? Patents, Industrial Fellowships, and Corporate Laboratories in the 1920s[*]

In 1923, Harry Steenbock, one of the scientists who worked on the single-grain experiment, sent a petition to the University of Wisconsin Board of Regents to apply for a patent for fortifying foods with vitamin A, not because he wanted to put the fortification into use, but because he wanted to *prevent* the oleomargarine industry from using it. Steenbock had just conducted pioneering experiments demonstrating the connection between yellow pigmentation and the vitamin in foods, and, seeming to confirm the suspicions of agricultural chemists in the pure food debates, Steenbock showed that colorless oleomargarine was in fact deficient in the vitamin. Though this appeared to be a win for the dairymen of Wisconsin, Steenbock realized that, if scientists were able to isolate vitamin A, this line of research might also show how vitamin A could be added to deficient foods. "The result is, that by the use of these preparations in the manufacture of commercial oleos, oleos can be obtained which physiologically are not only equal but even superior to butter," Steenbock wrote to the dean of the college of agriculture. He continued, "The whole point to this matter is, that sooner or later, commercial interests will no doubt patent this process of concentrating the vitamines for use in oleos and other products, and I wish to raise the question if the Experiment Station ought not to take action itself in this direction."[790] The Board of Regents rejected Steenbock's proposal in 1924, and just as Steenbock had feared, oleomargarine companies began to fortify their products with vitamin A during this period.[791]

Less than ten years later, in 1932, Steenbock sent a different proposal to the director of research of the College of Agriculture. He had been approached by a former University of Wisconsin student and staff member, who was now working as a nutrition specialist for Lever Brothers Company, a company that produced manufactured edible fats, including oleomargarine.[792] The company was interested in establishing an industrial fellowship program in the department, for work "studying the nutritive value of fats with, of course, prominent attention being given to the new products which Lever Brothers are contemplating to put on the market," Steenbock wrote.[793] Though there was no guarantee that the research would produce valuable results for the company's "commercial and sales operation," Steenbock said the company saw value in the investment in order "to get the names of its products into scientific literature as the product is used in experiments in laboratories of repute." The company agreed that if the research

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[*] The chapter title was inspired by a quote in *Capitol Times* in 1925, that was written in response to the University of Wisconsin's resolution not to accept corporate gifts: "The soul of the University is not for sale to interests that are in the business of buying colleges and universities" to "aid in the preservation of the present economic frontiers." Quoted in: Merle Eugene Curti and Vernon Rosco Carstensen, *The University of Wisconsin: A History, 1848-1925*, vol. 1 (Madison: University of Wisconsin Press, 1949), 224.

[790] Harry Steenbock to Dean H.L. Russell, 13 February 1923, 9/11/13/2: Box 2: Folder 13 "R-Sd," Steenbock Papers, University of Wisconsin Archives.

[791] Schneider, "Harry Steenbock (1886–1967) A Biographical Sketch," 1241.

[792] Harry Steenbock recounted this in a letter to the director of research at the college of agriculture: "As I told you the other day, I was approached by Mr. Schaal, Dr. Anderson, and Dr. Godfrey of Lever Brothers relative to the establishment of fellowships, said fellowships to be applied to the nutritive value of fats. Mr. Schaal is a former student of ours, and as a matter of fact, a former member of the staff." Later, he wrote, "Contact was made with our institution through Mr. Schaal[…]" Harry Steenbock to Professor Noble Clark, 4 October 1932, Steenbock Papers, University of Wisconsin Archives. This is worth noting because it supports the idea that graduates hired by industry helped forge connections between corporations and universities.

[793] Harry Steenbock to Professor Noble Clark, October 4, 1932, Steenbock Papers, University of Wisconsin Archives.

revealed "facts working to the detriment of the company's product […] the results should be published nevertheless." However, in that event, "it was understood that the company would be given full opportunity to verify the data, to extend the scope of the experiments, and to otherwise disprove the results if such should seem to be in order."[794] The company did not control publication, but they would be given ample opportunity to reframe any negative results. Though the university would not be explicitly promoting the Lever Brothers products, these products would be the focus of the research, thus potentially providing commercially valuable information and an association of the products with a reputable scientific institution.[795]

With this proposal, Harry Steenbock and the agricultural chemistry department at the University of Wisconsin established an industrial fellowship that would have been unthinkable just ten years earlier. In the early 1920s, the agricultural chemistry department maintained a decidedly anti-oleomargarine stance and an explicit alliance with Wisconsin's dairymen, prompting Steenbock to propose patenting a process to protect the dairying interests of the state. By the early 1930s, the department was partnering with an edible fats manufacturer to conduct research on their new products. What was behind this dramatic shift?

This chapter examines the evolution of the connection between industrial food manufacturers and university scientists by focusing on the work of Harry Steenbock at the University of Wisconsin in Madison in the 1920s. After their groundbreaking single-grain experiment, Steenbock and his colleague Edwin B. Hart continued to study the role and occurrence of vitamins in foods, leading to several important discoveries. Steenbock became most famous for his discovery that irradiation could fortify foods with vitamin D, a process which he patented under a new organization called the Wisconsin Alumni Research Foundation (WARF). The vitamin D patent stimulated already growing connections between the UW agricultural chemistry department and industrial food manufacturers, particularly through new industrial fellowships as well as the recruitment of trained nutrition scientists to corporate laboratories. The changes at the University of Wisconsin over this decade – from being decidedly anti-corporate and closely aligned with farmers and dairymen to increasingly partnering with commercial food manufacturers – makes it an ideal site for examining the changes in nutrition science at land-grant universities. While the chapter will note evidence that these changes were not limited to the University of Wisconsin, more research on other land-grant nutrition scientists is needed to fully understand the rise of commercial funding of nutrition research during this decade.

In some ways, University of Wisconsin agricultural chemistry department's increasing partnerships with industrial food manufacturers in the 1920s is unsurprising, as it paralleled broader changes in research funding across scientific disciplines and across universities during this period. Indeed, Roger Geiger, in his foundational history of research universities from 1900 to 1940, writes that the mid-1920s marked the beginning of "a new era, the Privately Funded University Research System."[796] During this period, powerful foundations like the Rockefeller Foundation and the Carnegie Corporation began to partner with universities to fund scientific

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[794] Ibid.

[795] Lever Brothers Company was a British manufacturing company with a history of funding university research. They were primarily a soap company until 1929, when they merged with a margarine company to become UniLever. On their partnership with the University of Liverpool, see Sally M. Horrocks, "Industrial Chemistry and Its Changing Patrons at the University of Liverpool, 1926-1951," *Technology and Culture* 48, no. 1 (2007): 43–66.

[796] Roger L. Geiger, *To Advance Knowledge: The Growth of American Research Universities, 1900 - 1940* (New York: Oxford University Press, 1986), xii, https://doi.org/10.4324/9781315135694.

research.[797] Histories of industry-university partnerships often focus on engineering departments, especially at the Massachusetts Institute of Technology and Caltech. During this period, there was also a rise in the establishment of corporate laboratories for industrial research, most famously at General Electric, the American Telephone and Telegraph Company, and Du Pont.[798] Additionally, over the 1920s, companies increasingly established individual fellowships for research at universities on subjects of interest specific to their company or industry, like the one that the Lever Brothers established with the University of Wisconsin.[799]

The Lever Brothers partnership with the University of Wisconsin was also a part of a broader trend among food processing companies in the 1920s. Scholars have noted that food-processing was a leading industry in creating university partnerships during this period.[800] By 1930, a significant number of food processors were funding research at universities across the country. In a 1930 report on industrial fellowships, the National Research Council listed, for example, Coca-Cola funding research at Johns Hopkins, the Clinton Corn Syrup Refining Co. funding nutrition research at Iowa State College, Standard Brands (especially Fleischmann's Yeast) funding fellowships at nine different universities, Kellogg Co. funding a fellowship at Michigan State College, and Kraft-Phenix Cheese Corp. funding a fellowship at Rutgers University, among others.[801] This trend seems to have continued through to the 1940s. In 1944, in commenting on the remarkable rise in industry funding of research over the previous fifteen years, the National Research Council reported that "The largest number [of fellowships, scholarships, or grants for research] are awarded for work in chemistry, engineering, and food and nutrition."[802] The influence of processed food manufacturers on nutrition research continues to be a pressing contemporary issue, yet surprisingly little has been written about these early, formative alliances between food manufacturers and university nutrition scientists.[803]

Harvey Levenstein notes this trend in his foundational social history of American nutrition science, and contextualizes it in the consolidation of the food industry, as companies merged into giant food processing conglomerates like General Foods and Standard Brands during this period, and food products like milk, cheese, vegetables, and fruits—previously "the province of many small producers and distributors"—were increasingly produced by large growers who formed

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797 Robert E. Kohler, "Science, Foundations, and American Universities in the 1920s," *Osiris* 3 (1987): 135–64. Geiger, *To Advance Knowledge*, 176–88. The University of Wisconsin Board of Regents notably prohibited accepting funding from these types of foundations, as discussed later in the chapter.

798 Leonard S. Reich, *The Making of American Industrial Research* (New York: Cambridge University Press, 1985); David A. Hounshell and John Kenly (Jr.) Smith, *Science and Corporate Strategy: Du Pont R&D, 1902-1980* (New York: Cambridge University Press, 1988).

799 John W. Servos, "Changing Partners: The Mellon Institute, Private Industry, and the Federal Patron," *Technology and Culture* 35, no. 2 (1994): 221–57. Servos traces the creation of industrial fellowships at research universities to Robert Kennedy Duncan, a chemist who worked at the University of Kansas and proposed the idea of industrial fellowships in 1907.

800 Kohler (1987) writes: "Manufacturers also set up more of less systematic fellowship programs, led by Du Pont and the food processing industries. These programs were intended mainly to ensure privileged access to the supply of trained experts for industrial R & D departments" (146). Geiger also lists food-processing as among the firms that "regularly provided direct support of university research" (190). Kohler, "Science, Foundations, and American Universities in the 1920s"; Geiger, *To Advance Knowledge*.

801 Callie Hull and C.J. West, "Research Scholarships and Fellowships Supported by Industry," *Industrial and Engineering Chemistry, News Edition* 8, no. 15 (August 10, 1930): 3–6, https://doi.org/10.1021/cen-v008n015.p003.

802 Callie Hull and Mildred Mico, "Research Supported by Industry through Scholarships, Fellowships and Grants," *Journal of Chemical Education* 21, no. 4 (April 1, 1944): 180, https://doi.org/10.1021/ed021p180.

803 A notable exception is work by Sally Horrocks, who writes about these types of early partnerships in Britain: Horrocks, "Industrial Chemistry and Its Changing Patrons at the University of Liverpool, 1926-1951."

powerful grower cooperatives like Sunkist.[804] In an increasingly competitive marketplace, these organizations sought to advertise their products using new scientific ideas about vitamins and minerals. Food processing often removed these micronutrients from the food products, so the companies were also interested in processes to add the nutrients back in. Advertising and interest in fortification created funding opportunities for researchers. "In the prewar era the New Nutritionists looked to government, rather than to business, to support nutrition research, seeking aid from businessmen only in their roles as philanthropists," Levenstein writes.

> The governments, universities, and foundations they worked for were all at one remove, at least, from the food businesses. The atmosphere of the 1920s was much different. In place of suspicion, the rise of big business now engendered admiration, and the growth of food industries provided new opportunities for employment and funding for research.[805]

Levenstein argues that "pure" nutritional scientists saw the opportunity for a mutually beneficial relationship with industry, and began to argue for the merits of processed foods. Elmer McCollum, for example, condemned the use of white bread in 1929, but in the 1930s, became a consultant to General Mills and began emphasizing "the 'wholesomeness' of white wheat flour."[806] In 1917, Harvey Wiley declared that "'wholesome' foods were those which were 'simple and as near to nature as possible'"; but in the 1920s, as he began writing for *Good Housekeeping*, Wiley endorsed the products advertised in the magazine, which ranged from Jell-O to Fleischmann's Yeast to Cream of Wheat.[807] In discussing this trend, Levenstein is most interested in in how the food industry employed nutrition science rhetoric in their advertising. This chapter, instead, looks at the internal dynamics of a major nutrition science department in creating partnerships with industrial food processors.

Though the University of Wisconsin's partnering with food processing companies was a part of a broader trend, two interrelated factors make it a significant site for studying this change in nutrition science research. First, the University of Wisconsin was the largest nutrition science program in the country during this period, and thus had significant influence on the direction of the science. In 1979, in a survey of archival sources on American biochemistry, archivist David Bearman and biochemist John T. Edsall noted that the University of Wisconsin seemed to be at the center of a changing relationship between agricultural chemists and food manufacturers. They wrote that during this period, government support for feeding experiments at agricultural experiment stations became "insufficient" and that "Manufacturers of food products, anxious to exploit the advertising advantages of finding unknown nutritive properties in their products, and concerned to counter criticism of food processing techniques, took on support of much of this research." The authors continued:

> As a result of establishing connections with the food industries, the University of Wisconsin was able to support a massive biochemistry research program which granted over 140 Ph.D.'s between the wars. This was several times the number

[804] Levenstein, *Revolution at the Table*, 150–51.
[805] Levenstein, 155–56. Note that it is unclear whether Levenstein is considering the ways that nutrition scientists at the agricultural colleges and experiment stations need to frame their research as serving the farmers of their state. This complicates the idea that before this era, scientists were "at one remove, at least, from the food businesses."
[806] Levenstein, 155.
[807] Levenstein, 155.

> granted by any other American university, yet we know very little about how this department grew or how its research interests evolved. [808]

Bearman and Edsall pointed to the holdings of the University of Wisconsin library as valuable sources for tracing the "evolution both of the alliance [of the university and industrial concerns] at Wisconsin and of the research tradition which has dominated American nutritional biochemistry."[809]

The second factor that makes the University of Wisconsin a significant site in looking at the evolving relationship between food processors and scientists in the 1920s is Steenbock's patent for fortifying foods with vitamin D and creation of the Wisconsin Alumni Research Foundation (WARF). This was the first time an American nutrition scientist patented a process for food fortification, and was one of the earliest patents granted to a research university (WARF would in fact become a model organization for managing patents for other universities).[810] The funds created from WARF would become vital for maintaining research at University of Wisconsin throughout the Depression, and indeed still funds research today.[811] Steenbock's patent also sparked a debate that has been well documented by historian Rima Apple, over whether a public university could or should file a patent.[812]

This chapter builds on Apple's work by contextualizing Steenbock's decision to patent in the broader trends in the field of nutrition science at agricultural colleges and experiment stations as discussed in the previous chapters. Apple, Levenstein and other scholars often discuss the exclusion of oleomargarine from the irradiation patent as an example of industrial influence on research in the 1920s (in this case, the dairy industry controlling the research). For example, in noting that the University of Wisconsin "built a powerful research empire" through research partnerships with manufacturers which "helped bias nutritional research in the United States toward the commercial needs of the food industry," Levenstein writes, "Typically, when Wisconsin biochemists working for the milk industry developed a process for infusing pasteurized milk with vitamin D through irradiation, an elaborate scheme was concocted to prevent the process from falling into the hands of the rival oleo-margarine industry."[813] For many scholars, the alliance of the University of Wisconsin with the dairy industry was a part of the same movement of industrial partnerships—it shows how commercial interests were shaping the practices of

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[808] John T. Edsall and David Bearman, "Historical Records of Scientific Activity: The Survey of Sources for the History of Biochemistry and Molecular Biology," *Proceedings of the American Philosophical Society* 123, no. 5 (1979): 286.

[809] Edsall and Bearman, 286.

[810] As Elizabeth Popp Berman has described, patenting of university research was not a regular occurrence until the 1980s, when changes in government policies and in the "institutional logic" of universities facilitated the creation of patents. She briefly discusses Steenbock and WARF, noting that "by 1956 more than 50 universities had copied the WARF model by establishing independent research foundations of their own, though rarely were they so successful" (97). Elizabeth Popp Berman, *Creating the Market University: How Academic Science Became an Economic Engine* (Princeton, NJ: Princeton University Press, 2011).

[811] Geiger, *To Advance Knowledge*, 251.

[812] Apple, "Patenting University Research"; Apple, *Vitamania*. Apple outlines the arguments of the patent critics—who argued that publicly funded research belonged to the public, and worried that the ability to patent would allow industry to control the direction of university research—and Steenbock's justifications for patenting the process—which largely rested on the patent providing a protection for consumers against fraud, but also notably included his concerns with the oleomargarine industry. Just as he had stated in his argument for the university to patent a process for vitamin A fortification, he argued that the university should take out the patent on fortification with vitamin D largely to prevent the oleomargarine industry from using the process.

[813] Levenstein, *Revolution at the Table*, 158.

university researchers.[814] However, this assessment does not account for the way that the agricultural colleges and experiment stations had been closely aligned with their states' farming interests since their founding. In the broader scholarship on the commercialization of university research, the place of the connection of farmers and agricultural colleges is unclear.[815]

In his comparison of the debate over Steenbock's patent to patent debates in the 1980s, Grischa Metlay notes that a key change between the two periods was in how the debate participants defined "the public interest." In Steenbock's period, it was defined in opposition to "unregulated private enterprise," while in the late period, "'the public interest' was defined in opposition to the cumbersome federal bureaucracy."[816] Typical of the line of argument described above, Metlay writes that the exclusion of the oleomargarine manufacturers gave WARF a cartel status. However, building from Metlay's observation on the concept of "the public interest," it seems possible that the exclusion of the oleomargarine industry from the patent has more to do with how scientists were defining "the public interest"—in the earlier era, the "public" that agricultural scientists served, especially in states like Wisconsin and California, was composed largely of small producers - farmers and dairymen. But during this era, these industries consolidated and by 1930, "the public" was largely consumers, not small producers, and growers and growers' associations had become powerful entities akin to food processors. It is possible that the idea of serving a "public" of small producers created an entrance for large food manufacturers when small producers became large growers. This would be a powerful analytical lens to apply to these developments, but at present they go beyond the aims of this dissertation.

The remainder of the chapter is divided into three sections. The first section discusses Steenbock's irradiation patent in the context of the agricultural tradition of nutrition science, and the second section examines the patent as one of a number of factors that prompted partnerships between the University of Wisconsin scientists and food processors during this era. The chapter ends with a discussion of how the social role of nutrition scientists was transformed during the 1920s– from using nutrition science to defend traditional foodways in the wake of industrialization to using the science to engineer industrial processed foods to be nutritionally safe. While this transformation may have caused the decline of the alternative tradition of nutrition science among land-grant scientists, it was also rooted in that tradition itself. Vitamin research strengthened the connection of land-grant scientists with farmers by demonstrating that processed foods were nutritionally deficient, but this research also introduced the potential of fortifying manufactured foods. Steenbock created the irradiation patent largely to protect Wisconsin's dairymen from oleomargarine manufacturers, but the patent also demonstrated the lucrative potential of scientists partnering with food processors, and ended up attracting more food manufacturers to fund nutrition research. Lastly, the skepticism of nutritional chemical reductionism among land-grant scientists in fact created an opening for the defense of processed foods; scientists who had a holistic view of

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[814] See, for example: DuPuis, *Dangerous Digestion*, 91. Edsall and Bearman notably acknowledge this moment as a shift in the alliance of scientists. They note that "after 1925, the agricultural and economic bias of the nutritional research was significantly deflected." Edsall and Bearman, "Historical Records of Scientific Activity: The Survey of Sources for the History of Biochemistry and Molecular Biology," 288.

[815] For example, Berman writes, "While states had played a major role in funding higher education, historically they had not focused their efforts on scientific research, and they certainly had not tried to leverage science for the purposes of economic development." It is possible that she is categorizing agricultural chemistry as applied research, and that this statement is only meant to be about "pure" research. Of course, the line between "pure" and "applied" research in nutrition and agricultural chemistry is difficult to define. Berman, *Creating the Market University*, 16.

[816] Grischa Metlay, "Reconsidering Renormalization: Stability and Change in 20th-Century Views on University Patents," *Social Studies of Science* 36, no. 4 (August 1, 2006): 590.

nutrition admitted that in a balanced diet, no one food should be demonized. Situating Steenbock's work in the 1920s in the larger context of the agricultural tradition of nutrition science, it is clear that parts of that tradition created an entrance for industrial food manufacturers to fund research, and ended up contributed to its decline.

I. The Sunshine Patent

Harry Steenbock claimed that his most groundbreaking nutrition experiment started with a sick goat in 1912. The Wisconsin scientists were conducting more nutrition experiments using laboratory animals following the Single Grain Experiment when they noticed that, confined to the laboratory, the goat's bones were not assimilating enough lime (or calcium) on a diet of straw and grain, and the goat had developed rickets. But when the scientists turned the goat out to pasture, the symptoms of rickets disappeared. Even when they put the goat on the same ration in the pasture, the goat remained healthy.[817]

What was the goat getting from the pasture that was missing from the laboratory? In a later lecture, Steenbock stated that they looked through the literature and found other cases where laboratory animals failed to assimilate enough lime to prevent rickets. This was usually attributed "to an insufficiency of lime in the ration, to the occurrence of lime in a supposedly unavailable form, to lack of exercise, to intoxication of cells concerned with its assimilation, or even to infectious agents." Yet none of the hypotheses seemed to completely explain the phenomenon. Then, in 1919, the Wisconsin scientists learned of experiments conducted at the Lister Institute in London that showed that rats "could be made to grow by exposing them to quartz mercury vapor light, and, furthermore, [the Lister Institute scientists] found that the tissues taken from such exposed animals were also growth promoting."[818] The Wisconsin scientists realized that they – as well as many other scientists conducting animal nutrition experiments—had not used proper controls in their laboratory. They had not accounted for sunlight.

Other studies were developing that raised more questions on the ability of the animal body to absorb calcium, as a number of researchers began to examine the impact of both cod liver oil and light in preventing rickets.[819] "Just why light and cod liver oil should act in the same capacity presented a conundrum which, specifically served to obscure the etiology of rickets, and the etiology of deficient Ca assimilation," Steenbock wrote.[820] Drawing from the conclusions of the Lister scientists that had shown how light had activated the tissues of the laboratory rats, the Wisconsin scientists began to test whether light could activate grains and oils, with extraordinary results. Through these experiments, they found that they

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[817] Steenbock discusses the goat origins of the experiment in several presentations, including: "Certain Experiences in a Laboratory of Nutrition" (presentation, Wisconsin [Anti-] Tuberculosis, November 30, 1925); "Food and Light" (presentation, Wisconsin Medial Society, September 16, 1925); "The Importance of Light in the Maintenance of Animal Life," (presentation, National Academy of Science, November 10, 1926); Harry Steenbock papers, 1905-1960, Series 9/11/13 24M5-N9, University of Wisconsin-Madison Archives, Madison, Wisconsin. (Hereafter, Steenbock Papers, University of Wisconsin Archives.)

[818] Harry Steenbock, "Certain Experiences in a Laboratory of Nutrition" (presentation, Wisconsin [Anti?-] Tuberculosis, November 30, 1925), Steenbock Papers, University of Wisconsin Archives.

[819] Kenneth J. Carpenter and Ling Zhao, "Forgotten Mysteries in the Early History of Vitamin D," *The Journal of Nutrition* 129, no. 5 (1999): 923–27.

[820] Harry Steenbock, "The Importance of Light in the Maintenance of Animal Life," (presentation, National Academy of Science, November 10, 1926); Steenbock Papers, University of Wisconsin Archives.

> had changed inert crude fats such as olive oil, corn oil, and coconut oil into antirachitic agents as active as cod liver oil; that grains such as wheat, corn and oats—notorious for their rickets producing properties—had been made rickets preventing; and paving the way to the development of our conception as to what an antirachitic vitamin might be, we succeeded in activating one apparently pure organic compound, namely cholesterol, to such an extent that one-hundredth of a per cent added to a rickets producing ration made it rickets preventing.[821]

Steenbock and his colleagues had discovered how to fortify foods with vitamin D, the antirachitic agent, without imparting any taste or odor.

As we have seen in other developments in nutrition science in the United States, this pivotal moment did not arise from laboratory work alone, but from the movement between laboratory and pasture. Steenbock was aware that this research on vitamin D demonstrated the limits of the chemistry laboratory. "We now see that nutrition is not entirely a matter of chemistry," Steenbock stated in 1925, "But that physiological factors, like the divert action of sunlight, influence to a marked extent the quality of irradiable foods."[822] Here, as in other moments in the development of nutrition science, a land-grant scientist emphasized that a chemically reductionist approach to food was not sufficient for understanding the laws of nutrition.

Despite finding extraordinary results, Steenbock hesitated to publish before he could fully explain the phenomenon. In fact, as Rima Apple has described, he only decided to rush to publish after he received an urgent telegram from a former UW colleague at Iowa State University, professor of nutrition Amy Daniels. "PUBLISH VITAMIN D WORK AT ONCE DONT DELAY," Daniels wrote in 1924. In a subsequent letter, she explained that she had learned about another researcher working on irradiated fats, and that "this other individual was a 'pirate' – no names were mentioned and I don't know the section of the country where the work is being done, but the facts as stated so checked up with your findings that I sent the telegram."[823] Steenbock immediately released his irradiation paper for publication and asked *Science* to publish a short statement on his research as soon as possible.

Steenbock had already had the experience of being beaten out by another researcher with publication in his vitamin A experiments. Steenbock had delayed publishing that research because he was unable to isolate and thus chemically prove the connection of vitamin A and yellow pigmentation.[824] He also delayed publication, he wrote in a letter in 1920, due to "pressure of instructional work" at the University of Wisconsin.[825] He presented his research on the connection of pigmentation and vitamin A at a meeting of the American Society of Biological Chemists in

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821 Ibid.

822 "Badger science again scores a victory." Madison, January 2, 1925. Filed under "C.E. Trout", 9/11/13/2: Box 2: Folder 15 "T-U", Steenbock Papers, University of Wisconsin Archives.

823 Telegram and letter, Amy Daniels to Harry Steenbock, August 12, 1924, 9/11/13/2: Box 1: Folder "General Correspondence, 1925-1929; Correspondence of Special Importance," Steenbock Papers, University of Wisconsin Archives. Apple opens her chapter and article on Steenbock's patent with this telegram. She uses it to introduce a discussion of how Steenbock delayed publication because of his concern for the public; his concern was that premature publication, before being granted a patent, may lead to fraud. "For him, science should serve the public good," she writes (34). Apple, *Vitamania*, 33–34; Apple, "Patenting University Research," 374.

824 This is described in Schneider, "Harry Steenbock (1886–1967) A Biographical Sketch," 1240.

825 Harry Steenbock to Professor John M. Evvard, 19 January 1920, Harry Steenbock Papers, 9/11/13/2: Box 1: Folder 5 "E-F". Roger Geiger has described how at the University of Wisconsin during this era, "undergraduate pedagogy was a persistent preoccupation." Geiger, *To Advance Knowledge*, 207.

1919 (a meeting that was supposed to take place in December 1918, but was postponed).[826] He submitted the manuscript to *Science* after, and finally published his series of articles on the subject in 1919. By that point, however, Steenbock had narrowly missed the chance to claim priority on connecting vitamin A to pigmentation. In October, Steenbock wrote to the editor of *Science* about his disappointment that they had not yet published his manuscript. "One of my main reasons for sending this material to you, as you can readily infer, was to obtain priority in this field along a line of work in which this laboratory had been actively engaged for almost a year," Steenbock wrote. "As similar work has appeared from other laboratories in the meantime I have been defeated in my purpose."[827] Though Steenbock hoped that he might be able to claim priority through his conference presentation, this did not take precedence over publication. When Steenbock wrote to Leroy Palmer, an agricultural chemist at the University of Minnesota, objecting to an article in which Palmer stated that Drummond was the first researcher to demonstrate the pigmentation-vitamin A connection, Palmer responded that he "fail[ed] to see how" Steenbock's conference presentation had "any bearing on this matter." "You have certainly been in scientific work long enough to appreciate the fact that it is a difficult thing to establish priority of ideas," Palmer wrote. "So far as my experience goes, the only priority of work which is generally accepted is the priority of publication."[828]

This type of exchange, as well as Amy Daniels' warning about the "pirate," was part of a transformation in the culture of nutrition science, as it became increasingly competitive and focused on priority claims during the age of vitamin research. The allure of the Nobel Prize may have contributed to this, and after the falling out with Elmer McCollum (as discussed in Chapter 3), Steenbock was perhaps more invested in getting the University of Wisconsin's research recognized.

In Steenbock's correspondence with Amy Daniels and with his mentor and fellow vitamin researcher Lafayette Mendel, they connected a concern with priority to both scientific prestige and commercial potential. Daniels was aware of Steenbock's vitamin D work because Steenbock had asked her to test the effectiveness of his irradiated oils in her nutrition laboratory. "I hope that I may hear from you shortly, and that you will consider this entire matter <u>confidential</u>," Steenbock emphasized [his emphasis]. "The authorities here are very much excited about it as it explains a lot of discrepancies that we have observed in our feeding trials, and also because of its commercial possibilities." Steenbock wanted to keep the experiment confidential for both its scientific and commercial value.[829] When he wrote to Mendel about his "big time" research in "trying to

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[826] *Proceedings of the American Society of Biological Chemists*, thirteenth Annual Meeting, Baltimore, Md., April 24-26, 1919.

[827] Harry Steenbock to Dr. J. McKeen Cattell, October 6, 1919, 9/11/13/2: Box 2: Folder 13 "R-Sd", Steenbock Papers, University of Wisconsin Archives.

[828] Leroy Palmer to Harry Steenbock, May 31, 1921, 9/11/13/2: Box 1: Folder 12 "N-Q." Steenbock Papers, University of Wisconsin Archives. Palmer was quite critical of Steenbock in the tone of his letter. He wrote that it seemed that the main purpose of Steenbock reaching out to him was "to chide me on what appears to you to be an unfair treatment of you in connection with priority in the field of vitamines versus pigments. I am sorry you feel hurt in this matter for it was not my intention to appear 'to go out of my way to emphasize Drummond's work as antedating yours.' So far as I am aware, no one has attempted previously to arrange chronologically the experiments bearing on this point. Certainly one can look in vain in the papers which you have published for any reference to observations of others either for or against the ideas you expressed in those papers."

[829] Steenbock wanted to list Daniels as a co-author on her study, but she insisted that she simply wanted to be in the acknowledgements, because she was not a part of the initial experiments that developed the irradiated oil. Steenbock to Daniels, January 6, 1925; Daniels to Steenbock, January 12, 1925, 9/11/13/2: Box 1, Steenbock Papers, University of Wisconsin Archives.

correlate some of the elusive principles of nutrition," Steenbock stated that he had previously told Mendel "very little about this matter because of [his] reluctance to passively allow the commercialization of these findings."[830] In response, Mendel clearly saw the professional stakes:

> I hope that you will clinch the essential finding regarding the effect of the radiation on the non-potent fats so that there can be no question of any accidental error in reaching your conclusion; and then you should make sure that you are not deprived of the credit of the discovery to which you are entitled with connection to this investigation.[831]

Mendel ended his letter writing that he thought Steenbock's research would allow him to "survive McCollum's criticism of your 'rat experiments' without feelings of distress."[832] Even as the letters themselves show a collaboration and camaraderie between scientists, the understanding of a need for secrecy in these letters – as well as Mendel's reference to Steenbock's rivalry with McCollum – indicates a new competitiveness in the field. The letter also shows the way that the line between pure and applied scientists was not well defined – even as Steenbock had the interests of dairying in mind, he was clearly interested in discovering fundamental laws of nutrition.

Still, Steenbock's stated "reluctance to passively allow the commercialization" of his findings was as important as his concern over professional status in making his priority claim. This is clear in his communications with his main competitor in claiming priority– Alfred Hess of Columbia University, the "pirate" to whom Daniels referred in her urgent letter.[833] Hess had previously attempted and failed to fortify oils through irradiation, but, after hearing about Steenbock's success, had returned to these experiments and obtained positive results.[834] He had presented some of his results at the meeting of the American Pediatric Society in June of 1924, two months after Steenbock had submitted his manuscript to the *Journal of Biological Chemistry*. Steenbock had asked the journal to postpone publication until he obtained a patent, but after Daniels warned that Hess was preparing to publish, Steenbock released the manuscript for publication. The two scientists published articles and notices in the *Journal of Biological Chemistry* and *Science* during September 1924. In response, Steenbock wrote to Hess about their concurrent research pursuits: "It illustrates again how ideas are the product of the times rather than of the individual, and fortunately, science gains much by the rapid dissemination of knowledge as investigators are thus strengthened in their convictions." Steenbock stated that he had submitted his results to the journal in April (making clear his priority claim), and asked if Hess had filed for a patent.[835] Hess replied that he agreed that discoveries are "to a certain extent the product of the times" and said that he had not filed a patent: "in principle, the department is averse to patenting discoveries," he wrote, adding, "Personally I believe that the property of ultraviolet radiations on

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[830] Harry Steenbock to Lafayette Mendel, 29 May 1924. 9/11/13/2: Box 1: Folder "General Correspondence, 1925-1929; Correspondence of Special Importance." Steenbock Papers, University of Wisconsin Archives.
[831] Lafayette Mendel to Harry Steenbock, June 3, 1924. Letter. 9/11/13/2: Box 1: Folder "General Correspondence, 1925-1929; Correspondence of Special Importance." Steenbock Papers, University of Wisconsin Archives.
[832] Ibid.
[833] Harry Steenbock to Amy Daniels, February 19, 1925, Steenbock Papers, University of Wisconsin Archives.
[834] For a concise summary of the timeline of research on vitamin D, see: A.B. Davis, "The Rise of the Vitamin-Medicinal as Illustrated by Vitamin D," *Pharmacy in History Madison, Wis* 24, no. 2 (1982): 59–72. Harry Steenbock and Archie Black, "Fat-soluble vitamins XVII. The induction of growth-promoting and calcifying properties in a ration by exposure to ultra-violet light." *Journal of Biological Chemistry* 61, no. 2 (1924): 405-422; Alfred Hess, "Experiments on the Action of Light in Relation to Rickets," *Proceedings of American Pediatric Society* (1924).
[835] Steenbock to Hess, September 24, 1924, Steenbock Papers, University of Wisconsin Archives.

foods will not have wide dietetic application although its scientific importance may be great."[836] Hess saw the scientific value of the research, but did not see its commercial value. Months later, Hess and Columbia University would attempt to file a patent, but by that point, Steenbock had secured the patent rights.[837]

In retrospect, it is surprising that Hess did not see the commercial potential of the irradiation process. Rates of rickets in children had risen in the United States and Europe in the years following World War I, and the only product associated with its prevention was cod liver oil – which had an "undesirable" taste and odor.[838] Moreover, just as cornmeal was associated with pellagra and white rice with beriberi, oats was becoming known as a "rickets-producing" food.[839] There was thus an industry particularly interested in this fortification. The increasingly common occurrence of rickets, the offensive taste and smell of cod liver oil, and the potential interest of the powerful cereal industry all would seem to have made obvious the commercial potential of a tasteless vitamin D fortification.[840]

Steenbock may have seen the commercial potential that Hess missed because of his unique position as a researcher at a land-grant university. Agricultural scientists at land-grant universities were committed to serving their state's farmers, and the University of Wisconsin had been particularly closely tied to the state's powerful dairy industry since its founding. As historian Rima Apple has shown, though Steenbock claimed that he applied for the patent broadly to protect the public, it is clear that the specific threat of the oleomargarine industry to the dairymen of Wisconsin was a prominent force in patenting.[841] In 1925, in explaining his decision to patent the process, Steenbock wrote that he was convinced "of the responsibility that a University owes the public in the matter of preventing the unscientific exploitation of results obtained in its research departments," but he immediately followed with: "It was that very fact which led me to apply for patents because I foresaw the possibility where particularly the oleo interests might attempt to make use of my discovery in competition with dairy butter."[842] Steenbock tested the irradiation process on other products that would have powerful commercial interests, including "the antirachitic activation of fats, of grains and their products, of infant foods and their constituents, and of medical compounds," but the threat of oleomargarine was consistently named as a reason to patent.[843] In 1929, Steenbock wrote of his irradiation discovery: "It presented numerous opportunities for practical application and again [as with the vitamin A research] the oleomargarine

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[836] Hess to Steenbock, September 30, 1924, Steenbock Papers, University of Wisconsin Archives.
[837] Steenbock collected this correspondence and the timeline of publication for the legal team of the Wisconsin Alumni Research Foundation to support their patent claim. 9/11/13/1 WARF SPECIAL FILE, Steenbock Papers, University of Wisconsin Archives.
[838] Steenbock repeatedly described cod liver oil in this way. For example, in a letter to a physician in Ontario, Steenbock wrote: "If the process will turn out to be economical in execution, I am sure that artificial illumination of oils will come in vogue because by this process there is imparted to them a potency equivalent to cod liver oil without imparting any undesirable taste or odor." Letter, Harry Steenbock to Gilbert White, October 7, 1924, 9/11/13/2: Box 2: Folder 16 "V-Z", Steenbock Papers, University of Wisconsin Archives.
[839] Apple, "Patenting University Research," 384–86.
[840] Apple also notes that "Despite its undoubted curative and preventative benefits, cod-liver oil had a major disadvantage: it tasted awful." Apple, *Vitamania*, 45.
[841] Steenbock claimed that the patent would protect the public from fraud and fraudulent advertising and from another person patenting the process and then overcharging for its use. While these reasons for patenting were not unfounded, the threat of oleomargarine was discussed in filing the patent. Apple, "Patenting University Research." Apple, *Vitamania*, Chapter 2.
[842] Harry Steenbock to Carl Miner, March 18, 1925, 9/11/13/2: Box 1: Folder "General Correspondence, 1925-1929; Correspondence of Special Importance." Steenbock Papers, University of Wisconsin Archives.
[843] Ibid.

manufacturer was concerned. By the use of this process the oleomargarine manufacturer can make his product superior to butter in its bone calcifying property."[844] Steenbock had already tried and failed to prevent oleomargarine manufacturers from using research on vitamin A to fortify their products, and subsequently claim that their product was nutritionally superior to butter. He was determined to not allow that to happen again.

Yet the university again resisted Steenbock's urging to file a patent. The University of Wisconsin had not patented any research before; and in fact, few universities had. As Elizabeth Berman has argued in her study of the rise of commercialization of research in the 1970s and 1980s, during Steenbock's era, patenting went against the "institutional logic" of universities. Before the mid-to-late nineteenth century, university research was framed in the "logic of science"—scientists were meant to be disinterested in the possible application of their findings, and motivated by the pursuit of knowledge rather than financial gain. This explains why Hess wrote that his department was "in principle […] averse to patenting discoveries" (though, given that his department would apply for a patent soon after Steenbock, his belief that the process did not have commercial potential may have been a more important factor). Few universities had patented any discoveries at this time—this would go against the "logic of science," and a patent would also require university resources for management.[845] Steenbock wrote that part of the reason the University of Wisconsin would not file the patent was because the institution simply did not want to devote the resources to managing it. Steenbock noted that the need to manage the patent was a major barrier. "[The university administrators] are entirely willing to get all the benefits," Steenbock wrote in a letter to a fellow scientist, "but as you well know our state educational institutions are about as unwieldy as our federal or state governments. Most of our officers already are sufficiently loaded up with work that any new problems are considered more or less of a nuisance."[846] Steenbock made clear in statements that he was not interested in filing the patent for his own personal profit—again, this would go against the "logic of science" that Berman has outlined. One newspaper reported that Steenbock said he "did not intend to pervert his life's greatest work by selling it."[847]

Steenbock's solution was to create the Wisconsin Alumni Research Foundation (WARF), an organization that would manage the patent and use its profits to fund further research at the University of Wisconsin, Madison, which has been studied by a number of scholars examining patenting during this era.[848] With this solution, Steenbock could maintain his position that the patent was filed in the public interest, shielding both himself and the university from accusations of commercial interests. Steenbock maintained that the patent would serve the public by preventing fraud and funding further research. "Inasmuch as scientific research is not too well supported in our institution and inasmuch as facts obtained in research institutions are often unscrupulously exploited," he wrote, "I have seen fit to apply for patents covering the matter of

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[844] Steenbock continued: "He can justly claim that this dietary property is far more important than that due to its vitamin A content because rickets is far more prevalent than the symptoms resulting from vitamin A deficiency." Quoted in: Schneider, "Harry Steenbock (1886–1967) A Biographical Sketch," 1242.
[845] Berman, *Creating the Market University*, 96–97.
[846] Harry Steenbock to Carl S. Miner, 18 March 1925, 9/11/13/2: Box 1: Folder "General Correspondence, 1925-1929; Correspondence of Special Importance," Steenbock Papers, University of Wisconsin Archives.
[847] "Scientist Bares Way of Halting Anaemia," February 15, 1927, *Associated Press*. The clipping was included with a letter that says it is from a newspaper in Fort Worth, Texas. W.W. Morris to Harry Steenbock, 24 February 1927, Steenbock Papers, University of Wisconsin Archives. Steenbock responded that his discovery had nothing to do with anemia. The disease is not mentioned in the article; the headline was an error.
[848] WARF has most prominently been examined by Rima Apple and Greischa Metlay. Apple, *Vitamania*, 33–53; Apple, "Patenting University Research"; Metlay, "Reconsidering Renormalization."

irradiation of [various products]."[849] Steenbock's position at a public university framed his motivations for obtaining the patent and establishing WARF; this arrangement would serve the public by preventing exploitation of the fortification process and providing much needed research funding, and while the university would receive the benefits of the patent, it would not need to devote resources to managing it. After creating the patent, WARF licensed the patent to Quaker Oats in 1927.

Even with this solution, Steenbock's patent application still raised concerns over whether the products of research conducted at a state university could or should be patented, as Rima Apple has detailed. Steenbock defended his patent application by consistently stating that it was the job of the university to protect its research from commercial exploitation, and some others agreed.[850] One scientific consultant wrote: "the university can not feel that its responsibility ends with the publication of the results of a research. The universities are under definite obligation to do at least these things which they alone can do to conserve the value of their researches of their faculties for the benefit of mankind."[851] Steenbock pointed to the University of Toronto's patenting of insulin and the University of Minnesota's patenting of a thyroid treatment as important precedents, as patents that protected the public and provided further university research funding. Yet others pointed to Babcock's milk-fat test as an example of a UW research product that was not patented and thus provided a cheap tool for Wisconsin's dairymen. Frank B. Morrison, a professor of animal husbandry, called the Babcock tester an example of "the value of University research to the State and the monetary savings made possible by such research to our people."[852] A.J. Glover, the editor of *Hoard's Dairyman*, was a particularly vocal critic of the Steenbock patent. "Why should the public devote money to discovering new truths only to permit them to be patented and their use determined by some corporation?" he asked. "It seems to me that information discovered by the use of public money belongs to the public and it is difficult for me to understand how such discoveries can be patented and some private corporation determine how they shall be used."[853] Both the arguments for patenting the fortification process and the arguments against it cited the particular nature of research at a state agricultural college. According to Steenbock, they needed to patent the product to protect it from commercial exploitation and thus protect the public interest (as well as to protect the state's dairymen from competition with oleomargarine manufacturers). According to Glover and other critics, the university did not have the right to patent the products of their research – their research products were owned by the public.[854]

[849] Harry Steenbock to Dr. O.W. Joslin, 19 June 1925, 9/11/13/2: Box 1: Folder "General Correspondence, 1925-1929; Correspondence of Special Importance," Steenbock Papers, University of Wisconsin Archives.

[850] In his initial statement on the research in *Science* in 1924, he wrote: "To protect the interest of the public in the possible commercial use of these and other findings soon to be published, applications for Letters Patent, both as processes and products, have been filed with the United States Patent Office and will be handled through the University of Wisconsin." H Steenbock, "The Induction of Growth Promoting and Calcifying Properties in a Ration by Exposure to Light," *Science (American Association for the Advancement of Science)* 60, no. 1549 (1924): 224–25.

[851] Carl Miner to Harry Steenbock, 10 March, 1925, 9/11/13/2, Steenbock Papers, University of Wisconsin Archives.

[852] Quoted in Apple, "Patenting University Research: Harry Steenbock and the Wisconsin Alumni Research Foundation," 379.

[853] A.J. Glover to [Russell], 22 October 1925. Cited in Apple, "Patenting University Research," 378. It is particularly surprising that Glover did not support the patent given his strong connection to Wisconsin dairying. Historian Edward H. Beardsley notes that Glover believed that the ability of oleomargarine manufacturers to fortify their product would not hurt the butter industry; he was confident that consumers would still view butter as the superior product. Edward H. Beardsley, *Harry L. Russell and Agricultural Science in Wisconsin* (Madison: University of Wisconsin Press, 1969), 215 n. 22.

[854] Other challenged the patent on legal grounds, accusing Steenbock and WARF of monopoly practices, or claiming that irradiation was a natural process and thus Steenbock could not claim to own the process. It was on these grounds

Some critics of the patent expressed concern that patenting would specifically hurt the university's relationship with farmers; these critics seemed to correlate farming interests with the public interest in opposition to commercial interests. Historian Edward Beardsley argues that some of Steenbock's colleagues at the University of Wisconsin "feared that the existence of the foundation would divert college research *from its main purpose of aiding farmers*, by enticing scientists to spend too much time searching for patentable ideas" (my emphasis).[855] F.B. Morrison, professor of husbandry, was particularly concerned with how WARF put the irradiation patent in the hands of businessmen, who "would naturally have a capitalistic point of view, instead of the viewpoint of the farmer."[856] Morrison placed farming in opposition to commercial or capitalistic viewpoints. This is reminiscent of the arguments of state chemists like Edwin Ladd in the pure food debates, who positioned themselves as defenders of agriculturalists in the wake of commercial, capitalistic development.[857]

Of course, Steenbock also framed himself as a defender of agriculturalists in filing the patent, as protecting dairymen from oleomargarine manufacturers. Steenbock had concerns about the impact of commercialism on scientific research as well, concerns that declined in the years following his patent. Apple points out that Steenbock had a change of heart between the early 1920s—when he insisted that he was only interested in vitamins "from the scientific standpoint" and that commercial questions should be taken up by "consulting chemist[s] and technologists"—and the late 1930s—when he wrote that it was not his "desire to emphasize the practical unduly, yet it appears that there is no reason why certain phases distinctly scientific should not be given preference because of their utilitarian aspect."[858] Steenbock had been concerned about his identity as a "pure" scientist rather than an applied scientist, but in the era in which he created the patent, this concern seems to have dissipated. Again, how commercialism and pure/applied science related to the dairy industry is difficult to understand. Perhaps in the earlier era, Steenbock would claim that the way that his vitamin research supported the dairy industry was a happy consequence of pure research; that he was not working on manufacturing products, but was studying the nutritional quality of whole and traditionally processed foods.

Steenbock's patenting of the irradiation process was both a product of the agricultural tradition of nutrition science, as well as a cause of its decline. As with the single-grain experiment, the irradiation research came from studying animals outside of the lab, and demonstrated the limits of chemical reductionism. Steenbock was particularly attuned to the commercial potential of the process because of the connection of the University of Wisconsin to the state's dairymen, which motivated him to keep the process out of the hands of oleomargarine manufacturers. Because of his work at a public university, Steenbock argued that they needed to patent the irradiation process to prevent commercial exploitation and ensure that the process was used for the public good, including by funding future university research. But the lucrative patent also brought attention to

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that, in 1943, the Federal Court of Appeals in San Francisco ruled that Steenbock's patent was invalid. Apple writes that their ruling was: "the irradiation of foods with ultraviolet rays has a natural process; Steenbock had discovered it but not invented it; and, most significantly, as a natural process it could not be patented." WARF continued to fight this ruling in courts until 1945, when the Supreme Court refused to review the ruling. By this time, the patent had expired. Apple, "Patenting University Research," 392–93.

[855] Beardsley, *Harry L. Russell and Agricultural Science in Wisconsin*, 160.

[856] Quoted in Beardsley, 160.

[857] Apple also discusses how Morrison "worried that is university researchers were allowed to patent, they might be attracted to commercially feasible projects instead of to pure, noncommercial research." I have a slightly different argument here – that Morrison and others specifically were concerned about serving commercial interests instead of farmers. Apple, "Patenting University Research," 379.

[858] Quoted in Apple, 393.

the commercial value of nutrition research. By developing a fortification process, Steenbock moved into the realm of food engineering, and thus his research became more closely aligned with the interests of food manufacturers than the interests of producers of raw food materials.

II. Industrial Fellowships and Corporate Laboratories

As noted in the introduction, Steenbock filed his patent application during a period when universities across the country were increasingly partnering with private organizations to fund their research. Scientists at the University of Wisconsin, however, faced a unique situation when it came to funding, which might explain Steenbock's argument that "scientific research is not too well supported in our institution."[859] In his examination of the privatization of university research during this period, Geiger notes that the vast majority of private research funds in the 1920s came from foundations, most notably the Rockefeller Foundation and Carnegie Corporation, but the University of Wisconsin was the only research university to *prohibit* accepting these funds. "In a throwback to prewar anti-Rockefeller sentiment, the Wisconsin trustees in 1925 forbade the university to accept any foundation grants," Geiger writes. "The Wisconsin trustees soon rescinded their ban, but the foundations seem to have been wary for some time thereafter of provoking controversy in Madison."[860] This had a significant impact on research at the university. "Wisconsin was probably the most highly regarded state university and the most fecund producer of Ph.D.'s for the first two decades of the century," Geiger notes,

> but it fell out of step with the other research universities for much of the interwar period. Its president was not an academic, undergraduate pedagogy was a persistent preoccupation there; and foundation support was initially disdained. It was not until the late thirties that new leadership and substantial contributions from the unique Wisconsin Alumni Research Fund counteracted these tendencies.[861]

Understandably, the University of Wisconsin thus plays a small role in Geiger's study of the "the privately funded university research system," and perhaps other scholars have followed his lead. However, while the university may have "fallen out of step" with other universities in its other departments, the agricultural chemistry department at the university was thriving during this period—partially due to forging connections with industry and establishing industrial fellowships. In fact, the department was employing some of the practices taken up by other fields and universities that Geiger describes, despite the lack of funding from foundations and the strong sentiment against commercialization of research in the state.[862]

Before the agricultural chemistry department began establishing industrial fellowships in 1923, the department established some connections to industrial food manufacturers by soliciting donations of food materials from them, and sometimes offering companies advice from their

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[859] Harry Steenbock to Dr. O.W. Joslin, 19 June 1925, 9/11/13/2: Box 1: Folder "General Correspondence, 1925-1929; Correspondence of Special Importance," Steenbock Papers, University of Wisconsin Archives.
[860] Geiger, *To Advance Knowledge*, 154.
[861] Geiger, 207.
[862] Geiger, 175–77. Geiger notes that in the 1920s, there was a rise in this type of "direct industrial research" through fellowships, as well as other avenues, such as hiring graduates for industrial laboratories, and "donating equipment" in exchange for consulting, which we will see, were similar to the practices taken up by the UW chemistry department.

subsequent research.[863] For example, in the early 1920s, Oscar Meyer and Company furnished Steenbock's laboratory with various animal products, including pork livers. Though Steenbock noted that supplying the materials had "not been financially remunerative" for them, he also told the company how, in the experiments, the pork liver made "such excellent results" that it "might be the basis for chicken rations. […] It has occurred to me that possibly it might be profitable to put up a dried liver for use in poultry rations."[864] With this advice, the company began research on a dried liver poultry feed. In exchange for supplies, the company thus gained insight on a potentially profitable item. In 1921, Steenbock wrote to Sunkist asking them to supply his laboratory with a case of oranges each month. "I hope you will not consider this excessive," he wrote, "as from our experience with the milk powder people and the yeast people as well as other food manufacturers the benefits that have accrued to them from impartial assistance in the accumulation data of this kind have always well warranted the expenditure." He then made clear that the laboratory would be willing to conduct experiments for them in exchange for these supplies: "If there is any matter in this connection on which you desire information in particular, I shall be glad to convey such to you or, if within our legitimate sphere of activities, should be glad to institute experiments to obtain them."[865] In asking the Carnation Milk Products Company to send his laboratory twenty-five pounds of coconut oil, he assured them: "we are not going to see if this material is harmful to the public as a food; we are going to see if it has any antirachitic properties."[866] In exchange for donations of supplies, Steenbock made clear that these organizations stood to benefit from the research services and advice.

In 1923, with the encouragement from the Dean of the College of Agriculture, E.B. Hart, chair of the department of chemistry, began establishing "industrial fellowships."[867] Industrial fellowships were not unique to Hart's department. Historian John Servos traces the creation of industrial fellowships at research universities to Robert Kennedy Duncan, a chemist who worked at the University of Kansas and proposed the idea in 1907. Duncan's conceptualization of a fellowship program was similar to the fellowships established at the University of Wisconsin; they were temporary agreements for a company to fund research on a specific topic of concern, while the university would maintain control of publication. By 1909, Duncan had established eight fellowships at the University of Kansas, two of which were related to food – on how to use the waste products of buttermilk production and on the chemistry of baking. Servos writes that colleagues at the University of Kansas soon "grew uneasy with the narrowly conceived research" and critics "questioned the wholesomeness of any arrangement that made a state university the

[863] See, for example, Steenbock to Pabst Brewing Company, February 11, 1922; Steenbock to Carnation Milk Products Company, October 30, 1922, 9/11/13/2: Box 1, Steenbock Papers, University of Wisconsin Archives. In my research, a few land-grant chemists have mentioned that they had to pay for the supplies for their experiments. For example, Myer Jaffa wrote to Wilbur Atwater in 1901 on his study of fruitarians: "I have to pay for all the food and also something more besides. I am very much encouraged however at the interest that is manifested in this section on the food question, and am only sorry that we have not more funds at our command for the furtherance of work." Myer Jaffa to Wilbur Atwater, February 5, 1901, Jaffa Papers, Bancroft Library.
[864] Harry Steenbock to Oscar Meyer Company, 14 April 1922, 9/11/13/2: Box 1: Folder 9 "L-Mb", Steenbock Papers, University of Wisconsin Archives.
[865] Harry Steenbock to Mr. P.S. Armstrong (California Fruit Growers Exchange), 13 September 1921, Steenbock Papers, University of Wisconsin Archives.
[866] He continued: "I mention this merely because I am fearful less you may anticipate that we are about to condemn filled milk more than we have already done." Harry Steenbock to Mr. A.C. Oosterhuis (Carnation Milk Products Company), 30 October 1922, Steenbock Papers, University of Wisconsin Archives.
[867] Edsall and Bearman, "Historical Records of Scientific Activity: The Survey of Sources for the History of Biochemistry and Molecular Biology," 286–87.

partner of private firms," which prompted Duncan to move to the University of Pittsburgh in 1910 and set up the Mellon Institute of Industrial Research and School of Specific Industries.[868] Geiger notes that there was a rise in "direct industrial research" in the 1920s, particularly concentrated in engineering and especially at Caltech and MIT.[869] After the 1925 resolution that prohibited commercial gifts, industrial fellowships may have been particularly appealing to researchers at the University of Wisconsin because it allowed them to circumscribe the ban by claiming that fellowships were direct gifts to individuals, rather than gifts to the university.[870]

The agreements "provided that the department would assign a researcher to investigate a specific problem of concern to the company," write Edsall and Bearman. "In the Biochemistry Department this was always something to which a feeding experiment was ideally suited and could serve as a dissertation."[871] For example, the Kemp Brother Packing Company sponsored a fellowship for a Mrs. Schrader to examine "the comparative distribution of vitamin A in whole tomato juice" as well as the ability for canned tomato juice to maintain its vitamin C content and to be fortified with vitamin D (through the addition of irradiated ergosterol).[872] The Kemp Company would emphasize the vitamin content of their "sun-rayed tomato juice" in later advertisements (Figure 13). The Fleischmann Yeast company awarded a fellowship to Miss Hanning to study the "efficacy of irradiated yeast as a source of vitamin D for poultry and for cows."[873] The examples above—both of which include vitamin D fortification—reflect the way that Steenbock's irradiation process attracted food manufacturers to the University of Wisconsin. Apple describes how irradiation attracted attention from both the pharmaceutical and the food manufacturing industries, and in food manufacturing, "[i]nterested firms ranged from Anheuser Busch brewery and Fleischmann's, producer of yeast, to C.E. Wheelock, manufacturer of jams and jellies and Bottled Beverages, Inc. in Cleveland Ohio," who was working on a healthful, chocolate drink for kids. Apple notes that "Most of the many, many letters of inquiry met with rejection."[874]

[868] Servos, "Changing Partners," 226. For an examination of Duncan's creation of one of these fellowships, see Ellan F. Spero, "An Entrepreneurial Opportunity in Process: Creating an Industrial Fellowship in Early Twentieth Century America," *Management & Organizational History* 12, no. 3 (July 3, 2017): 199–215.
[869] Geiger does not discuss food processing, except to note that this industry was a prominent force in research funding. Geiger, *To Advance Knowledge*, 175–77.
[870] Edsall and Bearman, "Historical Records of Scientific Activity: The Survey of Sources for the History of Biochemistry and Molecular Biology," 287 See footnote 34.
[871] Edsall and Bearman, 287.
[872] Harry Steenbock, "Report for Year 1929-1930," Steenbock Papers, University of Wisconsin Archives.
[873] Ibid.
[874] Apple, *Vitamania*, 47.

Figure 13: "Kemp's Sun-Rayed Tomato Juice New York's Largest Seller," Caldwell Van Riper, Inc. Advertising Company, ca. 1940s, Indiana Historical Society. https://images.indianahistory.org/digital/collection/V0002/id/3170

When an industrial fellowship was established with the UW agricultural chemistry department, the terms made clear that the university would maintain ownership and publication rights of the research produced. When Mead Johnson and Company – a producer of infant formulas—established a fellowship in 1923 to study "the nutritive properties and the stability of nutritive properties of reconstructed milk," Hart and Steenbock distinctly stated that "the direction of the research shall be in complete control of the Department of Agricultural Chemistry," that "the results of the research shall be public property," and that "the results of this research (favorable or unfavorable) can be published only with the consent of the director of the Experiment Station, and upon the recommendation of the Department of Agricultural Chemistry."[875] Quaker Oats established several research fellowships to study the antirachitic activity of cereals (including of specific Quaker Oats products, such as Oat Groats, Muffets, Farina, Puffed Wheat, and Three Minute Oat Flakes) after obtaining the rights to Steenbock's patent. Throughout the 1920s, the fellowship agreements with Quaker Oats specified that research results "may be published in conformity with the usual procedure for the publication of research carried out by the Wisconsin Station."[876] In the 1930-1931 agreement, the language more explicitly stated that the fellowships would support independent scientific research. The understanding was that:

> the University in accepting this fund for the Fellowship herein created intends that it shall be used for the promotion of scientific knowledge in the field referred to,

[875] E.B. Hart to Dr. R.E. Keeler (Mead Johnson and Company), 30 January 1923, 9/11/4/1: Box 2, Hart Papers, University of Wisconsin Archives.
[876] "Memorandum", 9/11/13/1, Steenbock Papers, University of Wisconsin Archives.

> that the results of such research shall be made public by the University, through publication or otherwise, in any manner that it may deem desirable, keeping in mind that the public interest or welfare shall be dominant. [877]

They added, "Prior to publication by the University the results of these investigations are not to be used for sales promotion, except by previous consent of the University."[878] In the industrial fellowship contracts, the researchers sought to maintain independence from industrial concerns, and control over publication and advertising.

Advertising was a particularly motivating factor in funding university research among food processors, but the use of nutritional claims in promotions posed risks for both companies and scientists. After WWI, many food processors saw the benefit of advertising their products as rich in certain vitamins and minerals, as shown in the wide range of ads that promoted the vitamin content of various foods during this period.[879] However, there were companies that were concerned that nutritional claims in advertisements would in fact hurt their sales. In 1924, the Washburn Crosby Company – producer of Gold Medal Flour – sent their chemist to meet with Steenbock to learn more about his irradiation process. When Steenbock asked if they would be interested in using the irradiation process, the company responded:

> As a general rule, there is a pronounced hesitancy on the part of food manufacturers to take any part whatever in an educational campaign. On the other hand, they are eager to discover those things which have a sane sound demand and to change their product to meet this. So many fakes have been foisted upon the consuming public that to advertise foods with a new nutritional factor may actually diminish their distribution. It is to be greatly regretted that a genuine scientific discovery should be thus handicapped. Those of us in the scientific end of the cereal business would desire very much to use the activated products in our own homes as a health measure.[880]

In corresponding with The Dry Milk Company, Steenbock wrote that the "excessive enthusiasm" of certain manufacturers in making claims in advertisements had caused a negative reaction to irradiation from the medical profession; he hoped that his patent would help produce a more

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877 "Memorandum Agreement Between the Quaker Oats Company and the University of Wisconsin in Regard to the Continuation of an Industrial Fellowship at the University," signed April 30, 1930, 9/11/13/1, Steenbock Papers, University of Wisconsin Archives.

878 Ibid.

879 Levenstein, *Revolution at the Table*, 152–56; Apple, *Vitamania*, 13–32.

880 E.N. Frank (Washburn Crosby Company) to Harry Steenbock, 9 December 1924, 9/11/13/2: Box 2: Folder 16 "V-Z," Steenbock Papers, University of Wisconsin Archives. This was in response to Steenbock asking the company if they "would be at all interested in treating its products if it should be found feasible commercially. While my interest is primarily that of the scientific investigator, naturally I am anxious to know what attitude scientific work of the character of my experiments is looked upon by such companies as yours. I have no intention of proceeding along theoretical lines without hopes of having the experiments of practical value." Steenbock to Mr. E.M. Frank, Washburn Crosby Company, 4 December 1924, 9/11/13/2: Box 2: Folder 16 "V-Z," Steenbock Papers, University of Wisconsin Archives.

"wholesome" reaction.[881] The appearance of a nutritional claim in advertisements could work to diminish the work of nutrition scientists.

While the potential to use nutrition research in marketing made university partnerships attractive to many food processors, the University of Wisconsin scientists sought to tightly control advertising. WARF and Steenbock were particularly controlling of advertising in the early days of the organization. Apple writes that "WARF, and often Steenbock personally, oversaw the advertising campaigns of manufacturers licensed under the Steenbock patents to assure that companies did not make unwarranted claims and promises. WARF even produced its own public service advertisements to educate the public about vitamin D and irradiated products."[882] Companies did not always follow the terms of their agreements. In 1930, Steenbock wrote to Quaker Oats' head of advertising to contest their emphasis on "sunshine" in their ads, as well as their use of his photo in promotional pamphlets distributed to physicians, which Steenbock had not approved.[883] It seems as though partnering with a company, even with strict terms for advertising and publishing, could carry risks for scientists.

In addition to advertising, the companies stood to benefit from research services and advice more generally. As with companies who donated supplies, companies who sponsored industrial fellowships "received considerable advice and much routine chemical analysis," wrote Edsall and Bearman. "Industries which requested such routine services in the absence of fellowship agreements were denied them on the lofty, but untrue, grounds that the university did not permit its scientists to provide analytic services. It was broadly hinted that fellowship support might obviate these qualms."[884] While they analyzed the products connected with industrial fellowships, the University of Wisconsin researchers consistently rejected other requests for analytical work. For example, in response to a request to examine an infant formula, Steenbock wrote, "We receive many requests for work of this nature and naturally do not care to dissipate our efforts along many lines merely to satisfy transient interests in nutritive value of some particular product manufactured by a firm."[885] In 1925, when another infant formula company –Abbott laboratories—asked Steenbock to analyze the vitamin content of their product, he emphasized that this was "not a small undertaking." He continued, "If you are contemplating going into this field, I would advise you to add to your staff a man trained in such work because you will find the control of your products by outside laboratories practically prohibitive in cost."[886]

Many food manufacturers did just that. As industry was increasing its influence in university research through industrial fellowships, they were also establishing research facilities of their own. During this period, students of nutrition science increasingly found jobs in industry rather than academia. E.B. Hart attributed this rise in industrial employment opportunities to the popularization of nutrition during the First World War. "The extraordinary growth of interest in

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[881] Harry Steenbock to Mr. L.J. Auerbacher (The Dry Milk Company), 17 June 1929, 9/11/13/2: Box 1: Folder "General Correspondence, 1925-1929; Correspondence of Special Importance," Steenbock Papers, University of Wisconsin Archives.

[882] Apple, *Vitamania*, 44.

[883] Steenbock to William McKenzie (Quaker Oats), 19 August 1930, Steenbock Papers, University of Wisconsin Archives.

[884] Edsall and Bearman, "Historical Records of Scientific Activity: The Survey of Sources for the History of Biochemistry and Molecular Biology," 287.

[885] Harry Steenbock to Mr. Will C. Braun, 13 October 1920, 9/11/13/2: Box 1: Folder 1 "A", Steenbock Papers, University of Wisconsin Archives.

[886] Harry Steenbock to Dr. E.H. Volwiler (c/o The Abbott Laboratories), 6 January 1925, 9/11/13/2: Box 1: Folder 1 "A", Steenbock Papers, University of Wisconsin Archives.

foods and nutrition brought upon us by the war has stimulated and created a great many outlets for agricultural chemists," Hart wrote in 1922.

> Not only can they find employment in 48 experiment stations in this country and in the Department of Agriculture of the federal government, but in innumerable food processing concerns and they generally want agricultural chemists. This applies to the milling industry, to the dairy industry, to drug houses, etc.[887]

This rise in corporate laboratories was a part of a larger trend across industries during the 1920s.[888] By 1930, the amount of nutrition scientists being employed by industry was impacting the ability of the University of Wisconsin laboratories to retain graduate students. Industrial fellowships played a role in this, as companies could work to recruit their fellows. "The maintenance of continuity of personnel has possibly been a more difficult matter than in some other departments," Steenbock wrote, "due to the fact that industry is ever alert for an opportunity to employ high grade men."[889]

Industry was not only interested in hiring "high grade men;" they frequently hired women. In fact, through an examination of Harry Steenbock's correspondence with and about his female students, it seems like industry offered women serious research opportunities as they were facing limited options in academic work.[890] In academia, the positions most open to women trained in chemistry were in home economics departments, and though some home economics departments had rigorous research agendas, several of Steenbock's students discussed their disappointment with this work. Mary Buell – the first woman to earn a PhD in biochemistry at the University of Wisconsin –described frustrated attempts to start independent research while working in home economics at the University of Iowa; instead, her letter to Steenbock described butting heads with MDs, cleaning desks and equipment, and being pulled away from research to help on a colleague's work, whose "point of view is that I am being well paid for my time. What more could anyone want?" She continued, "As I think the situation over, I wonder very seriously whether I am the right person for the place."[891] After Buell obtained a position at Johns Hopkins, she declared of home economics: "I am done with it, in an official capacity, for all time. […] When I think that I might have been acting head of the department at Iowa City this year, I shudder."[892] Another former student wrote that the nutrition courses she taught in a home economics department were "very much simplified, omitting much of the interesting parts, the chemical equations, the why

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[887] Hart to Mr. O.E. Loomis, 13 January 1922, Hart Papers. Hart was writing in response to request for description of the requirements for becoming an agricultural chemist for a young man's magazine (Hart wrote that the requirements are the same as for an industrial chemist).

[888] Hounshell and Smith, *Science and Corporate Strategy: Du Pont R&D, 1902-1980*.

[889] Harry Steenbock, "Vitamin Research at the University of Wisconsin," 25 April 1930, Steenbock Papers, University of Wisconsin Archives.

[890] Levenstein describes how food manufacturers increasingly hired home economists and funded home economics work, including the *Journal of Home Economics*. He does not discuss the way that industry might have offered scientific research opportunities that were lacking in academia during this period. Levenstein, *Revolution at the Table*, 156–58.

[891] Mary Buell to Harry Steenbock, 2 March 1921, 9/11/13/2: Box 1: Folder 2 "B," Steenbock Papers, University of Wisconsin Archives. She continued, "They ought to have someone who is content with the daily routine of teaching the home ec girls, and the diabetic and nephritis patients."

[892] Mary Buell to Harry Steenbock, 21 November 1921, 9/11/13/2: Box 1: Folder 2 "B," Steenbock Papers, University of Wisconsin Archives.

and the wherefores."[893] Lila Miller, a UW graduate teaching chemistry in a home economics department at Mississippi State College for Women, wrote, "In a five months' combat with freshmen home economic students who have had chemistry thrust upon them as a part of their moronic torture, I have learned the real value of serious work in chemistry."[894] In another letter she declared: "To stay here is scientific death."[895]

These University of Wisconsin graduates were among those who wrote to Steenbock to see if he knew of other job opportunities. Steenbock often recommended his former female students for academic and industrial positions, and collaborated with women colleagues on experiments. On at least two occasions, Steenbock's recommendations of women for jobs and fellowships at universities and experiment stations were rejected due to their sex. After Rosemary Loughlin wrote to Steenbock that she was disappointed with extension work at the Department of Home Economics at the University of Illinois, Steenbock recommended her for a fellowship at the University of Minnesota. The university, however, responded that they were "quite anxious to obtain a man with this type of training."[896] When he recommended another female student, Odessa Dow, for a position at the Michigan Experiment Station, they responded, "We prefer to have a man for the position in question but if we do not succeed in finding a desirable man we will be glad to consider Miss Dow."[897]

Industry may have been more open to hiring female chemists. Writing to the University of Wisconsin about a job opening, a dry milk company stated that they "would appreciate a man but would also consider a woman for this position providing her training and experience were satisfactory."[898] While this may sound similar to the statements above, at Steenbock's recommendation, the company energetically recruited Odessa Dow.[899] Lila Miller was able to escape her so-called "scientific death" by obtaining a position at John Harvey Kellogg's Battle Creek Sanitorium, where the nutrition laboratory was run by director Helen Mitchell.[900] At least one other female student also obtained a research position with this laboratory, and another – Olive Logerstrom—worked as a researcher in the Chemical Research Laboratory of the Kellogg Company.[901] Armour and Company hired former student Mrs. J.E. Zapata (Emily Bresee), but this is not to overstate the company's seemingly progressive hiring practices – they checked with Steenbock that she did not have any "marked racial peculiarities or serious physical defects" before

[893] Sarilla [Menger] to Harry Steenbock, 16 December 1923, 9/11/13/2: Box 2: Folder 16 "V-Z", Steenbock Papers, University of Wisconsin Archives.
[894] Lila Miller to Harry Steenbock, 17 February 1928, 9/11/13/2, Steenbock Papers, University of Wisconsin Archives.
[895] Lila Miller to Harry Steenbock, 25 January 1928, 9/11/13/2, Steenbock Papers, University of Wisconsin Archives.
[896] R. Adams Dutcher to Harry Steenbock, 29 May 1921, 9/11/13/2: Box 1: Folder 9 "L-Mb", Steenbock Papers, University of Wisconsin Archives.
[897] Andrew J. Patten to Harry Steenbock, 9 August 1922, 9/11/13/2: Box 1: Folder 4 "D", Steenbock Papers, University of Wisconsin Archives.
[898] G.C. Supplee to E.B. Hart, 24 July 1923, 9/11/13/2: Box 1: Folder 4 "D", Steenbock Papers, University of Wisconsin Archives.
[899] "You and the people at Kansas must have given me wonderful recommendations," Dow wrote. Odessa Dow to Harry Steenbock, 30 September 1923, 9/11/13/2: Box 1: Folder 4 "D", Steenbock Papers, University of Wisconsin Archives.
[900] Steenbock had recommended Miller reach out to Mitchell when she was unhappy with the home economics position. Steenbock to Miller, 21 April 1928, Steenbock Papers, University of Wisconsin Archives.
[901] Emma Francis worked for the laboratory and corresponded with Steenbock about her experiments on rats. 9/11/13/2: Box 1: Folder 5 "E-F", Steenbock Papers, University of Wisconsin Archives. Olive Logerstrom correspondence: 9/11/13/2: Box 1: Folder 9 "L-Mb," Steenbock Papers, University of Wisconsin Archives.

hiring her.[902] (Steenbock assured them that "She is not a foreigner, but distinctly American having married a Mexican reported to be wealthy in Mexican lands."[903]) This is a very small sample, but it may show that the rise of industrial food science provided opportunities for women chemists that were limited in academia.[904]

What was the impact of corporate laboratories and corporate sponsorship of research on the research itself? One University of Wisconsin professor, Helen Parsons, later reflected on the difference between corporate endowed research, and working directly for a corporate laboratory. In the 1940s, while endowed by a yeast company, Parsons found that, rather than providing a potent form of vitamin B, raw yeast in fact caused a vitamin B deficiency because it went "right through" the digestive tract. At the time, yeast companies were promoting "yeast cocktails" as a health food. "The yeast companies were just red," she said. Yet, when her friend who was working directly for a yeast company "called the attention of the yeast company to the fact that her rats did not get on so well with that raw yeast, that you could not assay that raw yeast, that it was not doing what it was supposed to do," the company "blotted it out. They wouldn't have anything to do with it. They cancelled something she'd written up for publication." Parsons alerted the FDA, who, according to Parsons, had her friend deposit her research notebooks into a safety deposit box.[905] Parsons encountered similar resistance from cereal manufacturers when she demonstrated that egg white consumption could impact vitamin absorption in rats in the 1930s. Working at the University of Wisconsin, Parsons clearly saw herself as a watchdog of the claims of food manufacturers, even when she was endowed by them.

There is thus evidence that researchers could maintain some academic freedom while receiving industrial funding, as was stipulated in the fellowship agreements. There is also evidence that the laboratories established by corporations were respected by the scientific community. Steenbock and Hart corresponded regularly with scientists in these laboratories, who were sometimes their former colleagues and students – sharing reprints of their publications, recent findings and research peculiarities, and advice (particularly on managing rat colonies). Still, the rise of corporate funding and corporate laboratories changed the nature of the research. Even if the University maintained control of the research process and its findings, and declared that "the public interest or welfare shall be dominant" in their decisions to publish, the fellowship funders guided the research questions and subjects. Even if scientists in corporate laboratories had rigorous research agendas, their research was always dictated by the needs of the company. In the new corporate-funded nutrition science, the needs of the public were secondary.

III. The Changing Social Role of the Food Chemist

In 1932, the Wisconsin biochemistry department entered into the surprising fellowship agreement with Lever Brother Co., an edible fats company, described in the beginning of this

[902] Paul Rudnick to Dr. E. Truog, 14 March 1918, 9/11/13/2: Box 2: Folder 16 "V-Z," Steenbock Papers, University of Wisconsin Archives.

[903] Harry Steenbock to Armour and Company, 19 March 1918, 9/11/13/2: Box 2: Folder 16 "V-Z," Steenbock Papers, University of Wisconsin Archives.

[904] Sally Horrocks has written about women chemists in industry in the British context during this period: Sally M. Horrocks, "A Promising Pioneer Profession? Women in Industrial Chemistry in Inter-War Britain," *The British Journal for the History of Science* 33, no. 3 (2000): 351–67. See also: Margaret W. Rossiter, "Chemical Librarianship: A Kind of 'Women's Work' in America," *Ambix* 43, no. 1 (March 1, 1996): 46–58.

[905] Helen Parsons, interview by Steven Lowe, 1972, Oral History Program, University of Wisconsin-Madison Archives, Madison, Wisconsin.

chapter. Just one decade earlier, the biochemistry department had been decidedly anti-butter-substitutes, as they explicitly applied for the irradiation patent to keep the process out of the hands of oleomargarine manufacturers, and as they supported research on vitamin A because they thought it would give Wisconsin's dairymen a competitive advantage. This chapter has discussed several factors that influenced this shift, largely connected to funding. Steenbock's irradiation patent – which he applied for specifically to protect Wisconsin farmers –demonstrated the lucrative potential of nutrition science research, and attracted food manufacturers to fund university science. This was at a time when state funding was lacking, and the biochemistry department at the University of Wisconsin increasingly partnered with food corporations through industrial fellowships. At the same time, food corporations were establishing research facilities of their own and were actively recruiting trained chemists, which included women chemists unsatisfied with the positions available to them in academia.

How did the land-grant chemists themselves justify this shift in their thinking about nutritional value of foods? How did the "artificial foods" that agricultural chemists berated in the early twentieth century become "manufactured/processed foods" that they would work on improving by the 1930s? Historian Rima Apple has reasoned that, as the farming population declined, the state university shifted to serving consumers, and with a new focus on consumer health, the department became more invested in food fortifications.[906] This is a convincing argument, but rather than seeing this shift as one solely towards serving consumers, it is useful to also see it as a shift away from allying with farmers and dairymen and toward allying with processed food manufacturers. After all, nutrition scientists did have consumers in mind before the 1920s. Focusing on the shift in industry stakeholders in nutrition research reveals a significant change in how the scientists defined wholesome food, issues of poor nutrition, and their role in addressing these issues.

Early research on vitamins in some ways strengthened the alliance between land-grant chemists and farmers. Fresh fruits and vegetables were rich sources of vitamins, and growers' associations advertised the research of the agricultural colleges and experiment stations to promote their products, as seen in the advertisement from the Indiana Vegetable Growers' Association (Figure 14). Research into vitamins also initially seemed to support the vocal skepticism of processed "artificial" foods expressed by land-grant nutrition scientists in the pure foods debate (Chapter 2). This research was particularly threatening to processed food companies after the popularization of nutrition science during the First World War. Americans now turned to nutrition experts for advice and understood foods as combinations of nutrients. Without an understanding of vitamins, this focus on interchangeable nutrients could help to popularize substitutes like oleomargarine, as officials could portray highly processed substitutes as equivalent to "natural" or traditionally processed products.[907] Vitamin research, however, demonstrated a difference between these foods: not only were some vitamins easily destroyed in processing, but machine processing often deliberately and efficiently removed elements of food that contained vitamins. Thus, there was a significant difference in the vitamin content of hand milled and machine milled rice, hand skimmed and machine-skimmed milk, and white flour and wheat flour.[908] This posed a serious threat to food manufacturers.

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[906] Apple, "Patenting University Research."

[907] Schneider, "Harry Steenbock (1886–1967) A Biographical Sketch," 1241.

[908]McCollum wrote about the difference between hand- and machine-skimmed milk in response to a question from *Hoard's Dairymen* about using skim milk for rations of pigs. He wrote that "separator skim milk contain[s] hardly a trace of fat" and will thus not support growth, unless the pigs have ample ability to forage. "There is no doubt that hand skim milk is more valuable as a feed for calves and pigs than the practically fat free skim milk of the present

EAT VEGETABLES FOR VITAMINS

"Vitamins are required for growth in the young and for health and well being in the adult." Vitamin A prevents an eye disease Xerophthalmia; Vitamin B prevents beri-beri; Vitamin C prevents scurvy. (Ark. Agr. Exp. Sta. Bul. 176.)

Vitamins in Vegetable and Other Foods

Food	A	B	C
Cabbage, raw	**Rich**	**Rich**	**Very rich**
Carrots	**Rich**	**Rich**	**Fair**
Spinach	**Rich**	**Rich**	**Rich**
Tomatoes	Fair	**Rich**	**Very rich**
Lettuce	Fair	Fair	**Very rich**
Oranges	Little	**Rich**	**Very rich**
Beef fat	Little	Absent	Absent
Lean meat	Absent	Little	**Little**
Bread (white)	Unknown	Little	Unknown
Bread (whole flour)	Little	**Rich**	Unknown
Butter	**Very rich**	Absent	Absent
Milk	**Rich**	Fair	**Fair**
Eggs	**Very rich**	Fair	Absent
Yeast cakes	Absent	**Rich**	Absent

Ark. Exp. Sta. Bul. 176

Green leafy vegetables are very high in life promoting and energy giving properties. "Their special virtues lie in the desirable composition of the mineral content; in their richness in the three substances which protect against the deficiency diseases;—and in their corrective effects on constipation. They are especially rich in iron and in this particular respect take the place of red meats." ("The American Home Diet" by E. V. McCollum and Nina Simmonds.)

Issued by

Indiana State Vegetable Growers' Association

Figure 14: "Eat Vegetables for Vitamins"; advertisement produced by the Indiana State Vegetable Growers Association. Note that they used data from the Arkansas experiment station and referenced work by Elmer McCollum and Nina Simmons. This advertisement was sent alongside a letter to Harry Steenbock in 1922, asking him to send images of animals on vitamin-rich and vitamin-deficient diet to display at Purdue University. H.D. Brown to H Steenbock, August 12, 1922, 9/11/13/2: Box 2: Folder 16, Steenbock Papers, University of Wisconsin Archives.

In the early to mid-1920s, the University of Wisconsin scientists remained allies of Wisconsin's dairymen and used their vitamin research to support dairying. Steenbock's application to patent the irradiation process to keep it out of the hands of oleomargarine

day," he wrote. Elmer McCollum to *Hoard's Dairymen*, September 9, 1916, 9/11/13/2: Box 1: Folder 10 "McCollum," Steenbock Papers, University of Wisconsin Archives.

manufacturers clearly illustrates this. There are other sources from this period that show Steenbock's support of dairying as well; for example, in supporting The American Journal of Milk ("I am very glad to see this make its appearance," he wrote to the journal publisher, "and as I stated some time ago I would be glad to give any movement which can bring about some general and liberal utilization of milk as a human foodstuff, a most generous and undivided support."[909]) or in alerting *Hoard's Dairyman* that Wisconsin's penal institutions appeared to not use dairy products ("I should think it advisable for Hoard's Dairyman to look into this matter," he suggested, "because if hundreds of mature men and women can exist year after year with little or no dairy products in their diet it certainly would constitute a strong argument for oleomargarine and other interests."[910]) In 1922, Steenbock and Hart published a bulletin titled "Milk - the Best Food" – which included photos of laboratory animals fed milk compared with animals given the same restrictive diet without it (Figures 15-16). The bulletin described how the various vitamins and minerals, and the protein and fat content of milk made it a "perfect food."[911]

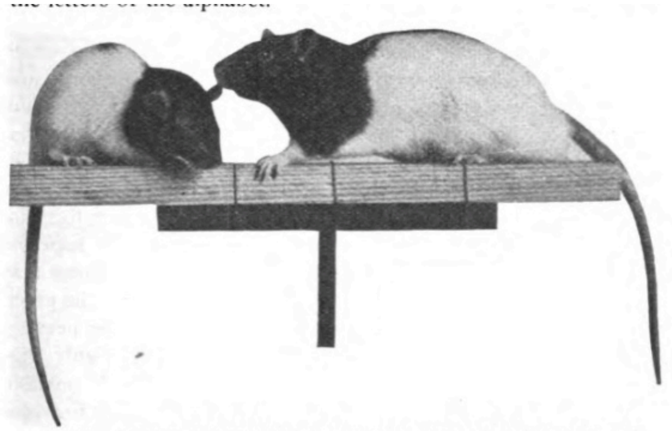

FIG 5.—OLEOMARGARINE VS. BUTTER FAT AS A SOURCE OF VITAMINE A.

Two rats of the same age and same sex. The rat on the left received as its source of vitamine A 5 per cent of the ration from a so-called butter substitute, while the rat on the right received as the source of this vitamine 5 per cent of the ration as butter fat. Note the small size (109 grams) and the sore and infected eyes of the rat on the left as compared with the vigorous condition, bright eyes and larger size (262 grams) of the rat on the right.

Figure 15: "Oleomargarine vs. Butter Fat as a Source of Vitamin A." Harry Steenbock and Edwin B. Hart, *Milk, the Best Food* (Madison: University of Wisconsin Agricultural Experiment Station, 1922), 9.

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909 Harry Steenbock to Mr. Henry Davis (American Journal of Milk), 13 February 1919, 9/11/13/2: Box 1: Folder 1 "A," Steenbock Papers, University of Wisconsin Archives.

910 Harry Steenbock to Hoard's Dairyman, 11 August 1924, 9/11/13/2: Box 1: Folder 7 "He-I," Steenbock Papers, University of Wisconsin Archives.

911 Harry Steenbock and Edwin B. Hart, *Milk, the Best Food*, Bulletin 342 (Madison: University of Wisconsin Agricultural Experiment Station, 1922), 3.

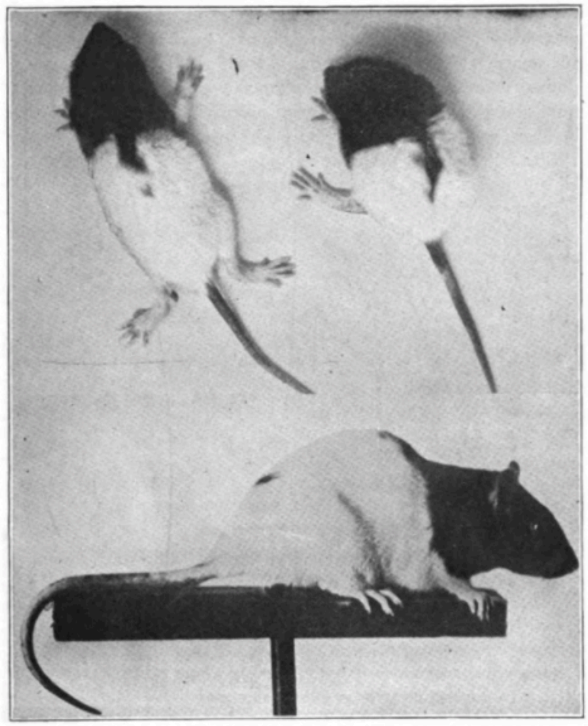

FIG. 9.—EFFECT OF MILK PRODUCED ON A RATION LOW IN VITAMINE B.

This rat received as a natural food only 10 per cent of the ration as barley grain. The rest of the ration consisted of purified materials. The supply of vitamine B was sufficient for her own maintenance, but not enough for both herself and an abundant supply in the milk. The young show the effect of this shortage. They grew rapidly for a time, but suddenly lost weight and showed periods of great excitabiliy. They had a rolling gait and often suffered from convulsions. This class of vitamines is present in sufficient amount in milk as normally produced from natural foods.

Figure 16: "Effect of Milk Produced on a Ration Low in Vitamine B." Harry Steenbock and Edwin B. Hart, *Milk, the Best Food* (Madison: University of Wisconsin Agricultural Experiment Station, 1922), 15.

Representatives from various industries accused the Wisconsin scientists of having an unfair bias towards dairying during this period, but the scientists maintained that they did not have any commercial biases. In response to the "Milk - the Best Food" bulletin, E.B. Forbes, a former chemist at Ohio State University working for the Institute of American Meat Packers, accused Steenbock of giving dairying preferential treatment. "Is milk the best food?" he wrote [*his emphasis*]. "Isn't any healthful component of the diet a perfect food of its sort? Is there any one best food?"[912] Steenbock replied that yes, he believed there was one best food, and he believed "that one best food to be milk." The bulletin was of course meant to advocate for wider use of milk, Steenbock stated, because

> there remains no doubt in my mind but that the more extensive use of milk both in the diet of the child and of the adult will be highly beneficial. / To my mind it is timely that scientific investigators stake their reputations upon advocating what they believe to be for the best interest of the people rather than to leave this to those interested from a one-sided economic point of view.[913]

[912] E.B. Forbes (Specialist in Nutrition, Bureau of Public Relations, Institute of American Meat Packers) to Harry Steenbock, 9 June 1922, 9/11/13/2: Box 1: Folder 7 "He-I," Steenbock Papers, University of Wisconsin Archives.
[913] Harry Steenbock to E.B. Forbes, 14 June 1922, 9/11/13/2: Box 1: Folder 7 "He-I," Steenbock Papers, University of Wisconsin Archives.

Steenbock framed his position supporting milk as a working in the interest of the public, rather than in commercial interests or the special interests of dairymen. In writing to a colleague about Forbes's letters, Steenbock wrote that he believed the meat packers were concerned with "the tendency of meat consumption taking such a decided slump." He also reported that the dairy interests had their own concerns about the nutritional claims of "the California Fruit Growers Exchange. The milk interests objected to the statement made in certain advertising that an antiscorbutant such as orange juice was a necessity where infants were fed pasteurized instead of raw milk." Steenbock concluded that he was happy to be outside of these types of commercial conflicts: "I am certainly very thankful that I am given the liberty to deal with facts obtained in the laboratory than with opinions of various commercial interests."[914] Strangely enough, in these letters, Steenbock discussed his promotion of milk—which seemed to be tied to dairying interests—as an example of him being outside of commercial influence.

While land-grant scientists demonstrated that farm and dairy products had a higher vitamin content than processed foods during this period, these scientists also expressed concern that the importance of vitamins was being overstated. Throughout his vitamin research, Steenbock consistently emphasized that his work on vitamins was more valuable to scientists than to consumers. "Truly, from the standpoint of the investigator, an appreciation of the role of vitamines has made and will make much progress in nutrition possible and in every way more complete," Steenbock wrote in 1918, "but from the standpoint of the people as a whole it is questionable if the possibility of a lack of vitamines in the diet is of more serious import than that of a lack of suitable proteins or mineral constituents." Though vitamins were a vital part of nutritional health, "safety has undoubtedly been assured to the consumer by his desire for variety."[915] He continued to express this sentiment throughout his vitamin research. In connecting vitamin A to yellow pigmentation, he wrote that the value of yellow corn over white corn was overblown. "We have treated this matter with the greatest conservativism for the reason that we appreciate, from our other nutritional work, that it is dangerous to spread information of this kind promiscuously unless the exact relations which a particular food stuff may occupy in the diet have been thoroughly established," he wrote to a colleague at the University of Kansas. He continued, "inasmuch as no individual or no animal should rightfully have its vitamine come from one source, such as corn in the diet, it is questionable of how much practical importance this difference in composition may be."[916] The "practical significance" of his vitamin A research was minor, Steenbock consistently emphasized. "After all," he wrote to a colleague at Cornell, "it is the sum total of properties of a ration that have to be taken into consideration and too much emphasis should not be placed on the specific dietary properties of any one constituent."[917]

Other scientists also noted the issue of emphasizing the relative nutritional value of one food item over another due to its vitamin content. Myer Jaffa, professor of nutrition at the

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914 Harry Steenbock to Professor A.W. Hopkins, 1 August 1922, 9/11/13/2: Box 1: Folder 7 "He-I," Steenbock Papers, University of Wisconsin Archives.

915 Harry Steenbock, unpublished manuscript – "Vitamines and Nutrition", 1918, 9/11/13/2: Box 2: Folder 13, Steenbock Papers, University of Wisconsin Archives. This manuscript is a draft of this article, though the quoted segments are not in the published article: Harry Steenbock, "Vitamines and Nutrition," *The Scientific Monthly* 7, no. 2 (1918): 179–88.

916 Harry Steenbock to Professor John H. Parker, 28 November 1920, 9/11/13/2: Box 1: Folder 12 "N-Q", Steenbock Papers, University of Wisconsin Archives.

917 Harry Steenbock to Professor G.F. Warren, 21 October 1919, 9/11/13/2: Box 2: Folder 16 "V-Z," Steenbock Papers, University of Wisconsin Archives.

University of California, Berkeley, made similar comments in the 1920s. In 1925, Jaffa traveled to Europe to assess food relief programs, and at a children's clinic in Vienna, suggested that the researchers supplement the children's diet with "concentrated California orange juice" to make up a vitamin C deficiency. Yet, in an article about his trip, Jaffa stressed that it was not that California orange juice was particularly special; it was that the children were eating poor quality foods. "'Oh the whole moral of vitamins is to eat a varied diet,' exclaimed Professor Jaffa," as reported by the journalist. "'Vitamins are found in all foods and we need all six forms.'"[918]

This idea that variety in diet is more important than valuing one food over another for its vitamin content in fact began to be used to defend vitamin-deficient processed foods. Elmer McCollum, in writing to a former University of Minnesota chemist who was working for Russell-Miller Milling Co., made this claim in defending the use of white flour: "What we must do is cease giving various individual food products, especially bolted flour [i.e. white flour], a black eye," he wrote, "and instead teach both the public and especially the food officials. Teach them about the matter of making successful combinations of food stuffs."[919] In 1933, McCollum, now a consultant to General Mills, again reiterated this sentiment. "All of our natural foods are deficient or lacking in one or more nutrient principles," he wrote, "but the keynote to successful nutrition is not in eating a single food which is complete and adequate nutritionally, but in making such combinations of our best agricultural products as will provide in one what is lacking in another."[920]

It is in this line of thinking that Steenbock's anti-oleomargarine stance waivered in the 1920s. Steenbock consistently made clear that butter contained the fat-soluble vitamin that was missing in butter substitutes like oleomargarine, but from very early on he was skeptical of the importance of this difference. "While butter fat is richer in this dietary essential than butter substitutes," he wrote in 1918, "it is still too early to predict if, in the aggregate, this special property of butter fat warrants its taking a superior place in the mixed diet."[921] In 1919, he ended a letter to Dorothy Mendenhall of the Children's Bureau with a statement "in regard to the present day propaganda that is in progress in regard to the use of butter fat in preference to other fats in the mixed human diet." He wrote, "I am entirely out of sympathy with the emphasis that is being placed on the use of butter fat in the diet of the adult in preference to other fats because as you may note in our publication some butter fats are exceedingly poor in their fat soluble vitamine content, in fact poorer than animal body fats." Even though butter had more vitamins than oleomargarine, the vitamin content of different butters varied dramatically. In addition, the vitamin requirements of the body were not clear:

> Inasmuch as we know nothing of the fat soluble vitamine requirements of the human it seems to me that the whole matter is being over emphasized and that much more carefully planned work should be done before the public is unduly aroused

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918 "Oranges Saving Lives in Austria: California Professor Shows How to Remedy Deficiencies in Vienna Milk; Vitamin "C" Supplied; Myer E. Jaffa Tells of Nutrition Problem in War-wrecked City," *The Summer Session Californian*, July 14, 1925, Volume 1, Jaffa Papers, Bancroft Library.

919 Elmer McCollum to Dr. Harry Snyder (Russell-Miller Milling Co.), 22 July 1916, 9/11/13/2: Box 1: Folder 10 "McCollum", Steenbock Papers, University of Wisconsin Archives.

920 Elmer McCollum to Products Control Division of General Mills, Inc., 29 November 1933, Steenbock Papers, University of Wisconsin Archives. Levenstein, *Revolution at the Table*, 155.

921 Harry Steenbock, unpublished manuscript – "Vitamines and Nutrition", 1918, 9/11/13/2: Box 2: Folder 13, Steenbock Papers, University of Wisconsin Archives.

and the opportunity is given to various commercial enterprises to take advantage in a commercial way of the lack of information.[922]

Steenbock stressed a fear of commercial exploitation of the overvaluing of vitamins in the diet. The tone of his statement was also similar to Jaffa's 1925 tone – even though their research demonstrated the valuable vitamin content of their states' farm products (butter in the case of Steenbock, and orange juice in the case of Jaffa), they did not want this value to be overstated. Adequate nutrition was not derived from eating specific foods, but from eating a balanced, varied diet.

Margarine manufacturers were quick to point to the seeming contradiction in Steenbock's statements about mixed diets and his support of the use of butter due to its vitamin A content. "Would not 'the general use of a mixed diet' obviate the danger of too little fat soluble A to the same extent as in the case of the water soluble type of vitamine?" wrote J.S. Abbott, of the Institute of Independent Margarine Manufacturers, directly quoting from a bulletin by Steenbock and Hart on the water soluble vitamin (today, the B vitamins). He continued:

> I fail to see the justice in the literature from our universities and public institutions being so prejudicial to the consumption of oleomargarine when nobody lives on oleomargarine alone and when it could not possibly be used to the exclusion of other food stuffs which contain the fat soluble A. The widespread propaganda to the effect that it is dangerous to the public health to substitute oleomargarine for butter because of the larger quantity of fat soluble vitamine in butter is certainly not warranted by facts.[923]

Steenbock responded defensively that he had, in fact, made these points in his publications. "I have taken occasion to point out before it was done in any other laboratory in this country that butters might be just as poor in fat soluble vitamins as oleomargarine," he wrote, and that in the literature, "You would also find that I was the first one to point out the extensive distribution of the fat soluble vitamine in plant materials which all tend to minimize the superior value attributed to butter as compared with oleomargarine when used in the mixed human dietary." Though Steenbock emphasized that he was "entirely disinterested in any special propaganda," he also defended his position that butter was better than oleomargarine for children – "I desire to take the attitude that for the growing young and for the sick the best, judiciously used, is none too good."[924] Indeed, though he defended the use of oleomargarine in a mixed diet, he made clear elsewhere that he would not recommend it "as a general procedure in a community where we may have at stake the health of some, even though a very small majority of the population," he wrote, repeating the

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922 Harry Steenbock to Dr. Dorothy Reed Mendenhall (Children's Bureau, United States Department of Labor), 17 November 1919, 9/11/13/2: Box 1: Folder 11 "Mc-Mz," Steenbock Papers, University of Wisconsin Archives.

923 J.S. Abbott (Institute of Independent Margarine Manufacturers) to Harry Steenbock, 14 September 1920, 9/11/13/2: Box 1: Folder 7 "He-I," Steenbock Papers, University of Wisconsin Archives.

924 Harry Steenbock to J.S. Abbott, 13 October 1920, 9/11/13/2: Box 1: Folder 7 "He-I," Steenbock Papers, University of Wisconsin Archives. Dorothy Mendenhall also made this point in responding to Steenbock's criticism of denouncements of oleomargarine. She wrote that she did "not feel that it is wise to advocate the use of other fats to the exclusion of butter fat in the diet of an infant or in fact to do anything to lessen the use of butter fat for children until our knowledge of the nature and source of vitamine is much more complete." Dr. Dorothy Reed Mendenhall (Children's Bureau, United States Department of Labor) to Harry Steenbock, 25 November 1919, 9/11/13/2: Box 1: Folder 11 "Mc-Mz," Steenbock Papers, University of Wisconsin Archives.

line he had used in discussing the diet of children, but applying it to the general population: “All in all, I think most of us will take the attitude that the best is none too good.”[925]

While scientists spoke out against the idea of demonizing certain foods due to their lack of vitamins (as the use of any one vitamin-deficient food would be insignificant in a varied diet), they were particularly passionate in denouncing commercial food manufacturers making the opposite claim – that their special supplements or mixtures had particular health benefits that made them superior to natural or traditionally processed foods. This was especially the case when it came to manufactured animal feeds – scientists in California and Wisconsin vocally criticized the claims of commercial feed manufacturers, writing that their mixtures contained elements that were not needed in the animal diet, and that the farmer could put together a simpler, effective feed at a much lower cost. In 1905, for example, UC Berkeley chemist Myer Jaffa published a bulletin titled “Poultry Feeding and Proprietary Foods,” in which he addressed the proliferation of commercial feeds while explaining how a poultry feed could be made cheaply and easily. “If any one wishes to use the proprietary foods and pay the price asked, well and good,” he concluded. “But the station will always condemn and expose the sale of products which do not have the nutritive value claimed for them, and the labels of which are, to say the least, misleading.” When poultrymen become educated on how to mix their own feed, he wrote, “the sale of proprietary or condimental foods will be very small.”[926] In the 1920s, the claims of commercial feed manufacturers became more advanced as they drew from research on vitamins and minerals. E.B. Hart was particularly critical of mineral feed mixtures being marketed during this period. To one company, he wrote that he believed their feed contained “a lot of useless things […] We believe that you can accomplish the same thing that you are accomplishing now by the use of a simple mixture, and I believe you ought to be able to do it a lot cheaper.”[927] Agricultural chemists consistently denounced the claims of commercial feed manufacturers that their special supplements were superior to hand-mixed feeds.

This criticism applied to supplements in human foods as well. “There is probably no science which has made greater progress in the last decade than nutrition,” wrote Myer Jaffa in a 1928 article on dieting fads and commercial dieting products,

> but at the same time no science has suffered as has nutrition in the hands of faddists and those who market commercial food and vitamin preparations, the labels which savor a repetition of the patent medicine propaganda with which the general public has been so long struggling.[928]

Jaffa made it clear that good nutrition did not require commercial preparations. Just as Steenbock wrote that the desire for variety obviated the need to understand vitamins, and just as Hart described how farmers could easily create healthful feeds without supplements, Jaffa emphasized that nutrition was simple. “There are only two functions of food. 1) To promote growth and sustain life. 2) To maintain health, activity and ability to work,” he stated. “If common sense rules are followed our food will do these things for us. If not, they won’t.”[929]

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[925] Harry Steenbock to Mr. Fred W. Hein, 23 December 1919, 9/11/13/2: Box 1: Folder 7 “He-I”, Steenbock Papers, University of Wisconsin Archives.
[926] Jaffa, *Poultry Feeding and Proprietary Foods*, 22.
[927]E.B. Hart to Mr. John R. Chapman, 16 January 1923, 9/11/4/1: Box 1, Hart Papers.
[928] “Fat Folks—Beware! Professor Warns Against Reducing Fads,” newspaper clipping, December 19, 1926, 6, Volume 1, Jaffa Papers, Bancroft Library.
[929] Ibid.

Even in discussing his own development of the irradiation process for fortifying foods with vitamin D, Steenbock at times made clear that the importance of this fortification should be muted. In 1930, in corresponding with Quaker Oats and the Food and Drug Administration about their advertising of irradiated products, Steenbock pointed out that

> the small amounts of Vitamin D contained in the Quaker products might not be considered very valuable by the laymen, except for the fact that if it were assumed that irradiated foods of various kinds were consumed to the exclusion of all others, in such event the consumer would have a sufficient intake of Vitamin D to completely protect him against any deficiencies.[930]

The vitamin D fortification would only matter to consumers on restrictive diets. Any study of the impact of the irradiated cereals would need to control all of the meals of the research subjects. "The amount of vitamin D in irradiated cereal is too small to overcome variations which might be induced in the vitamin D in the entire diet by the consumption of eggs, for instance," he wrote, "to allow the insurance of clean-cut results."[931] In 1927, a man wrote to Steenbock asking what he would recommend for children who would not eat cod liver oil. Rather than recommending one of the products fortified with vitamin D through his irradiation process, Steenbock wrote, "In place of cod liver oil I recommend the use of yolk of egg. This is particularly rich in vitamin D when the eggs are produced by chickens that have access to sunlight."[932]

This raises the question: Given that scientists like Steenbock argued that a balanced, varied diet of decent quality foods obviated any need for special supplements or even any need for eating one particular type of food, was the shift at the University of Wisconsin to working on food fortifications really a shift from serving farmers to serving consumers? In some ways, the answer is unequivocally "yes." The occurrence of rickets had steadily increased among children throughout the nineteenth and early twentieth century, often linked to increased industrialization (especially the lack of sunlight from smog). Fortification of foods with vitamin D effectively eliminated the disease as a public health concern.[933] Rima Apple notes on food enrichment that "Groups such as the US Department of Agriculture would have preferred to educate the public about wholesome food selection and food preparation, but they recognized that education was a long-term project."[934] Partnering with food and drug manufacturers was an important part of distributing fortified foods and eradicating the disease quickly, and certainly prevented much suffering, particularly among children.

In the case of pellagra, there was a similar discovery of a supplement that prevented the disease during this period. In 1925, Joseph Goldberger—the scientist described in Chapter 3 who persistently worked to prove that pellagra was not an infectious but a nutritional deficiency disease—demonstrated that brewer's yeast worked to cure pellagra.[935] The distribution of this

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930 Steenbock to William McKenzie (Quaker Oats), 19 August 1930, Steenbock Papers, University of Wisconsin Archives.

931 Ibid.

932 Harry Steenbock to Mr. Fred Haesloop, 20 April 1927, Steenbock Papers, University of Wisconsin Archives.

933 Philippe Hernigou, Jean Charles Auregan, and Arnaud Dubory, "Vitamin D: Part II; Cod Liver Oil, Ultraviolet Radiation, and Eradication of Rickets," *International Orthopaedics* 43, no. 3 (2019): 735–49.

934 Apple, *Vitamania*, 7.

935 Joseph Goldberger, GA Wheeler, and WF Tanner, "Yeast in the Treatment of Pellagra and Black Tongue. A Note on Dosage and Mode of Administration.," *Public Health Reports* 40, no. 19 (1925): 927–28.

cheap supplement by the Red Cross helped to end the epidemic in the American South.[936] However, like Steenbock, Goldberger's enthusiasm for the use of yeast as a supplement to cure or prevent the disease was muted. "In closing note it may be well to emphasize that in all but the severe cases of pellagra careful feeding is all that is needed," Goldberger concluded his article on brewer's yeast. "In our judgment, it is only in cases of more than average severity, or where such foods as fresh milk and fresh meat can not be procured, that yeast may serve a valuable purpose and may help to save life."[937] Brewer's yeast certainly saved many lives, but increased access to a variety of quality foods would have too. In 1915, when Goldberger first connected pellagra to poor diet, he suggested that the way to cure it was to "improve economic conditions, increase wages, reduce unemployment" and "make the other class of foods [other than carbohydrates] cheap and accessible."[938] One can see how distributing brewer's yeast provided an easier solution than addressing poverty in the American South.

Supplements and fortifications were industrial solutions to industrial problems. They did help consumers, but they also helped producers of highly processed foods, whose foods might have otherwise caused acute illness (if used in a diet based purely on manufactured foods). In 1925, Morrison defended the University of Wisconsin's decision to refuse to grant the irradiation license to oleomargarine manufacturers. "If human suffering could be alleviated only by licensing the irradiation of oleo margarine, then I would agree that we would be remiss in our duty if we opposed it," he stated. "However, it is not necessary for people to secure the anti-rachitic property of oleomargarine."[939] One way to see the University of Wisconsin's partnering with food manufacturers in the 1920s is simply as a story of funding – without adequate state funding, the agricultural chemistry department turned to industry, who saw the commercial potential of funding nutrition research. Another way to see it is as a surrender to an industrial food system, or a change in the vision of nutrition scientists as the protectors of not only consumers, but also smaller scale agriculturalists in the industrializing food system.

The anthropological approach to studying food and diet, the skepticism of processed foods, the anti-corporate sentiment, and perhaps most importantly, the general criticism of nutritional reductionism that defined the earlier, agricultural tradition of nutrition science declined during this period. Ironically, some of the core characteristics of that tradition led to its decline. Research into vitamins – which seemed to show the superiority of natural or traditionally processed foods and validate concerns about new processed foods and chemical reductionism –also provided the tools to isolate and add vitamins back into manufactured foods. The desire to protect agriculturalists from food manufacturers motivated Steenbock to take out a patent, which in turn showed how lucrative nutrition research could be at a time when public funds for research were dwindling. The anti-reductionist arguments of scientists were also used to claim that any one food – including processed foods – should not be condemned. Perhaps, looming over all of this, the decline could be connected to a general lack of control over the food system itself. At the beginning, there was a hope that chemist might provide a check on the industrial food system, not only to protect consumers, but also to protect farmers from "counterfeit food." By 1930, perhaps this vision of the food system no longer seemed tangible, and land-grant nutrition scientists had to

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[936] Michael A Flannery, "' Frauds,'" Filth Parties,"" Yeast Fads," and" Black Boxes": Pellagra and Southern Pride, 1906-2003," *The Southern Quarterly* 53, no. 3 (2016): 121.
[937] Goldberger, Wheeler, and Tanner, "Yeast in the Treatment of Pellagra and Black Tongue," 928.
[938] Bryan and Mull, "Pellagra Pre-Goldberger," 139.
[939] Quoted in Apple, *Vitamania*, 47.

work with the food system at hand, moving from a check on industrial food manufacturers, to an instrument of them.

By 1930, the close alliance of land-grant nutrition scientists with their local farmers and dairymen had weakened as scientists established new connections with processed food manufacturers. A number of these scientists lamented the way the public now looked to fortification and supplements to solve problems of malnutrition, rather than focusing on a balanced diet of natural or traditionally-processed foods. Malnutrition had become a problem to be solved by food engineering, partially due to the research efforts of the land-grant nutrition scientists themselves. A number of them questioned the new direction of the field, a field which, by the end of the decade, had its own peer-reviewed journal and national professional society. Though certain aspects of the agricultural tradition of nutrition were not lost during this era, new commercial, scientific, and social motives allowed for the quantitative, reductionist way of thinking about food to become synonymous with the science by the 1930s.

In the 1930s, agricultural chemists at UW Madison did not seem to see their growing connections with food manufacturers as impacting the science. In an article in 1931 that contested the Board of Regents' 1925 resolution to not accept corporate funding, both E.B. Hart and Stephen Babcock were listed among faculty who "asserted their freedom of action in opposing the resolution of the regents." The article continued, "All concurred in the opinion that the receiving of gifts, without strings, to the university from corporate foundations would not compromise complete academic freedom."[940] The article listed the private donations that the University of Wisconsin had received, including from several large food manufacturers, including J. Ogden Armour (meat packing), H.J. Heinz Company, Quaker Oats Company, Gustav Pabst (beer), and William Wrigley Jr. (baking powder and chewing gum).[941] "The university has accepted money from such sources but only on the condition that the results are open to the public, and are for publication in any journal, or for use in any way that the public sees fit to use them," the article explained. "As several of our professors put it, all state universities are feeling cramped for funds to go ahead with this most vital work. Danger of social economic control from gifts for such purposes seems to us too remote to be real."[942] By the end of the twentieth century, when nutrition research was largely funded by corporate sponsors, it seems as though the danger was more real than they realized.

[940] "Shall the University Accept Gifts from Educational Foundations?," *The Wisconsin Alumni Magazine*, March 1931. Steenbock Papers, University of Wisconsin Archives.
[941] Ibid. 228.
[942] Ibid. 229.

Conclusion: "Persona Non Grata"
History and the Emergence of the Discipline of Nutrition Science

By the 1920s, the field of nutrition science had changed significantly from the science that had emerged in U.S. land-grant colleges and agricultural experiment stations in the 1890s. The work of dietary surveys was no longer undertaken by agricultural chemists, but rather was the work of home economists and rural sociologists.[943] Chemists studying nutrition were increasingly confined to the laboratory and work with small animals. Chemists who had been allied with agricultural interests and cautious of processed foods were now working with those food processors to engineer highly processed food to be more nutritious. Once based in publicly-funded agricultural colleges and experiment stations in the 1890s, by 1930, nutrition science had begun to shift to corporate laboratories and/or corporate sponsorship. From studying diets at the table of their research subjects, breaking down the nutrient values of whole or minimally-processed foods, and broadly connecting their studies to their farming constituents as publicly-funded scientists, chemists now studied the impact of specific nutrients on rats in laboratories, increasingly sponsored by corporate food processors. This trend continued, and by the late twentieth century, corporations would be the dominant setting for nutrition research.[944]

Along with these shifts in the 1920s was the transformation of various fields of nutrition into a distinct discipline. In 1928, the *Journal of Nutrition* published its first issue and the American Institute of Nutrition (AIN) was established, with Harry Steenbock and Elmer McCollum, among others, as charter members. The organizers of the journal and institute, John R. Murlin and Charles C. Thomas, had met resistance to this idea when they proposed it to scientists a decade earlier—including from Harry Steenbock.[945] "I do not hardly believe it advisable to organize a new and separate society devoted to the field of food and nutrition," Steenbock wrote. He explained,

> [M]any of the men now interested in nutrition work are interested as well in other lines of work and therefore do not care to segregate their interests in a society not closely affiliated with the biochemists, physiologists, pharmacologists and pathologists. Furthermore, I take it the new organization as conceived would not include those of us who are interested in animal nutrition as well as human nutrition. As considerable work which applied to both of these fields is now being done in experiment stations, and according to all indications much more of it will be these in the future, I think these lines should remain very closely tied.[946]

By 1928, Steenbock and others had changed their minds. This change may signify that, with the establishment of a society and journal, the field was cohering into a clear discipline.

Some of the first histories of the field, published in the 1920s, helped solidify the new discipline by endowing it with an origin narrative and defining its boundaries. Foremost among

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943 Dirks and Duran, "Experiment Station Dietary Studies Prior to World War II: A Bibliography for the Study of Changing American Food Habits and Diet over Time," 1254.

944 Marion Nestle, "Corporate Funding of Food and Nutrition Research: Science or Marketing?," *JAMA Internal Medicine* 176, no. 1 (2016): 13–14.

945 HH Williams, "Founding of the American Institute of Nutrition, Including Commentaries on the Founders," *Federation Proceedings* 36, no. 6 (1977): 1916.

946 Harry Steenbock to Liet. Col. John R. Murlin, April 23, 1919, Harry Steenbock papers, 1905-1960, 9/11/13/2: Box 1: Folder 11, University of Wisconsin-Madison Archives, Madison, Wisconsin.

these histories, as we have seen, was Elmer McCollum's *The Newer Knowledge of Nutrition* (1922).[947] McCollum was invested in making his own priority claim, and scientists at the time accused him of downplaying the roles of other scientists in the discovery of vitamins. Indeed, *The Newer Knowledge of Nutrition* reads as though McCollum himself invented the "biological method" of experimentation. The work of scientists at the University of Wisconsin (here and elsewhere) is not mentioned.[948] In discussing the exclusion of a number of University of Wisconsin experiments from the history, Edwin Hart wrote to Lafayette Mendel: "Evidently the University of Wisconsin is *persona non grata* among some of our explorers in biological chemistry…it is all very interesting in depicting the character of men, even scientists."[949]

Decades later, McCollum's apparent erasure of the longer, more complex history of nutrition science's roots was echoed in the work of other historians. Historian Harmke Kamminga has suggested that the history of nutrition science, largely written by scientist-historians like McCollum, has been "bound inextricably with the establishment of a separate science of nutrition" and thus the "explicitly value-laden bits" are excluded. [950] Possibly, these historians downplayed or ignored agricultural chemists and experiment stations because these historians were committed to making the case that nutrition science was a serious, value-free, and laboratory-based discipline, rather than a holistic and "value-laden" pursuit. Experiment stations' connections with farmers and farming may also account for their excision from the historical record. Most of these historians have anachronistically focused on the urban Northeast, even though northeastern scientists at the time seemed to look west for academic work in food science.[951]

This geographically narrow focus may in part be enabled by a problem of archival invisibility: Northeastern and industrial chemists wrote popular books, were discussed in newspapers, and lived and worked in or close to the nation's financial, political, and communications centers. Not a few enjoyed minor celebrity status. Dispersed across rural America and working with and for farmers, on the other hand, agricultural and station scientists were more remote and their work, more work-a-day and far less glamorous. As scientist-historian Howard Schneider noted of Hart of the University of Wisconsin, despite all of Hart's work on vitamins, he was not associated with any discovery or isolation of a vitamin. "It may be, of course, that with his predilection for the practical a chance was lost for the construction of scientific monuments, or at least monuments of archival visibility," Schneider writes.[952]

As this dissertation has argued, when we ignore the work of the agricultural scientists, the social-science aspects of early nutrition research, the connection of scientists to farmers, the skepticism of these scientists in solely using chemical methods, and the value they placed on taste and custom, we are left with an impoverished understanding of the history of the nutritional sciences. What was in fact one, particular strain of nutrition sciences—the urban, Northeastern strain, which placed a great deal of emphasis on supposedly "pure" quantitative, lab-based

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[947] Note that the first edition of *A Newer Knowledge of Nutrition* was printed in 1918, but the 1922 edition was entirely re-written, and more focused on the history of the science.
[948] In McCollum's *A History of Nutrition* (1957)*,* he also makes no mention of the University of Wisconsin and implies that he and his coinvestigator (Davis) invented the "biological method of research" entirely on their own (220). McCollum, *A History of Nutrition*. McCollum, *The Newer Knowledge of Nutrition: The Use of Food for the Preservation of Vitality and Health*. See also: Semba, "The Long, Rocky Road to Understanding Vitamins," 88.
[949] Quoted in: Semba, "The Long, Rocky Road to Understanding Vitamins," 92.
[950] Kamminga, "Nutrition for the People," 38.
[951] Isabel Bevier, Stephen Babcock, and Edwin Ladd are examples of this. See Introduction.
[952] Howard A. Schneider, "Harry Steenbock (1886–1967) A Biographical Sketch," *The Journal of Nutrition* 103, no. 9 (1973): 1237.

analysis—is generalized as the dominant or even the only nutritional science. In fact, as this dissertation has shown, a variety of institutions, motivations, methods, and geographies shaped the work of nutrition scientists in the late 19th and early 20th centuries. The tradition of nutrition prominent in the Northeast was certainly significant in the establishment and development of nutrition science, but before the First World War, another tradition contended with the "pure" science of the Northeast. Its practitioners pursued a different vision of research and had a different conception of the scientific, social, and political role of scientists. The agricultural tradition of nutrition that flourished in the Midwest and West was consequential for the early regulation of food and helped create a paradigm shift in the science. Paradoxically, it also played a critical role in fostering the first partnerships between universities and food processers.

Examining scientists working in the agricultural tradition of nutrition science in the Midwest and California, including Myer Jaffa, Edwin Ladd, Stephen M. Babcock, Harry Steenbock, and to a certain extent, Harvey Wiley, among others, reveals a different origins narrative of how the science progressed and an alternative possible trajectory for its development. These scientists used laboratories to break down the chemical components of food, and they created food budgets and dietary guidelines based on this quantitative approach. However, their study of nutrition involved much more than numbers. They were skeptical of an assessment that reduced food to its chemical components, partially due to their work with farmers, but also because they recognized that taste, custom, and environment were important factors in diet.

The role of the taste of food in nutrition, for example, was particularly important in their studies. In the dietary surveys, scientists noted the importance of foods that added "relish" to the diets, and they defended taste as an important component of appetite, digestion, and general well-being, writing that it would be "foolish" not to consider it. They noted the value of fruits and vegetables in an attractive diet even when the chemical standards at the time seemed to mark fruits and vegetables as nutritionally worthless; stating that they did have value for adding this pleasure to the diet. Even Harvey Wiley noted the importance of the difference in the taste of olive oil and cottonseed oil, among other items, to argue that a mixed product needed to be labeled. In the early vitamin experiments, taste was seen as an important enough factor that Elmer McCollum added cheese flavoring to the experimental rations for rats, as he questioned whether the animals were not doing well simply because they did not like the taste of the rations. And, as we have seen, taste was also a vital factor in creating guidelines during the First World War –as Alonzo Taylor noted, rations needed to meet psychological as well as physiological needs, and taste was important to both food conservation and morale. One might even see taste as shaping Steenbock's work on food fortifications –after all, there was a nutritional supplement that worked to prevent rickets—cod liver oil—but (as my own grandmother could attest from vivid memories of being made to consume it as a child in the 1920s) it tasted bad. Harry Steenbock's fortification was exciting and appealing because it was tasteless.

Taste was an important consideration for these scientists not only for its connection to appetite, digestion, and indeed, pleasure, but also because they were skeptical that chemical methods could fully measure the healthfulness of a diet. This skepticism may have been rooted in their dietary survey work—where they observed healthy individuals eating diets that were different from the accepted nutritional standards of the time—or from their work with farmers and farm animals, as McCollum noted that those working in animal feeding knew that chemical standards could be taken only as a general guide. Babcock observed that farm animals given a single-item ration, for example, always foraged for a mixed diet. Or the skepticism of agricultural scientists could have been rooted in Babcock's observation that he could not tell the difference between dung and food by the current chemical standards in the early 1880s, an idea that was repeated by other scientists, and that contributed to Babcock's design of a single-grain experiment to show there was more to food than chemical analysis could reveal. Either way, this skepticism was fundamental to early vitamin research in the US.

Finally, this dissertation complicates the commonplace narrative that nutrition scientists have always been the partners of large food processing companies. In the late 19^{th} and early 20^{th} centuries, agricultural scientists were critical of new, highly processed foods and chemical preservatives, and spoke out against "imitation" products like oleomargarine. Their caution has been attributed to them having a farming bias—and they certainly did have a farming bias. But none saw their partnership with farmers as antithetical to scientific work in chemical analysis and nutrition. Indeed, many, including Edwin Ladd, Myer Jaffa, Stephen Babcock, Harvey Wiley, and Harry Steenbock, used chemical analysis to help create a fair system for farmers to work with processors. While expressing concern about a degrading quality of food in the industrializing food system, especially for vulnerable people like children, they nevertheless sought to use chemistry as one of many tools to create a food system that was at once nutritious, in the full and holistic sense of the term, and fair.

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