Lawrence Berkeley National Laboratory

Recent Work

Title

DISTRIBUTION OF RADIOACTIVITY IN THE EGG AFTER FEEDING SODIUM ACETATE-1-C14

Permalink

<https://escholarship.org/uc/item/063293f0>

Authors

Kritchevsky, D.
Grau, C.R.
Tolbert, B.M.
et al.

Publication Date

1951-02-06

UNIVERSITY OF CALIFORNIA - BERKELEY

UNIVERSITY OF CALIFORNIA

UCRL- 1108

TWO-WEEK LOAN COPY

*This is a Library Circulating Copy
which may be borrowed for two weeks.
For a personal retention copy, call
Tech. Info. Division, Ext. 5545*

RADIATION LABORATORY

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

Contract No. W-7405-eng-48

Distribution of Radioactivity in the Egg after

Feeding Sodium Acetate-1-C¹⁴

David Kritchevsky, C. R. Grau

B. M. Tolbert and Barbara J. Krueckel

February 6, 1951

Berkeley, California

DISTRIBUTION OF RADIOACTIVITY IN THE EGG AFTER
FEEDING SODIUM ACETATE-1-C¹⁴ *

* This work was sponsored by the U. S. Atomic Energy Commission.

by

David Kritchevsky, C.R. Grau, B.M. Tolbert and

Barbara J. Krueckel (Introduced by John H. Lawrence)

From the Radiation Laboratory and the Division of Poultry Husbandry, University
of California, Berkeley, California

ABSTRACT

Radioactivity was found in the yolk, albumen and shell of eggs following
the feeding of sodium acetate-1-C¹⁴ to a hen.

To be published in the Proceedings of the Society for Experimental Biology
and Medicine.

DISTRIBUTION OF RADIOACTIVITY IN THE EGG AFTER
FEEDING SODIUM ACETATE-1-C¹⁴ *

* This work was sponsored by the U. S. Atomic Energy Commission.

by

David Kritchevsky, C.R. Grau, B.M. Tolbert and

Barbara J. Krueckel (Introduced by John H. Lawrence.)

From the Radiation Laboratory and the Division of Poultry Husbandry, University
of California, Berkeley, California

Earlier work on the distribution of radioactivity in eggs following the
administration of radioactive isotopes of phosphorus, strontium and iron has
been discussed in the comprehensive treatise of Romanoff and Romanoff (1).

(1) Romanoff, A.L., and Romanoff, A.J., "The Avian Egg", John Wiley and Sons,
Inc., New York, 1949, p. 363.

More recently, further work has been carried out using isotopic phosphorus (2)

(2) O'Neil, J.B., Jowsey, R., Lee, C.C., Reade, M.A., and Spinks, J.W.T.,
Science, 107, 295 (1948).

and calcium (3,4).

(3) Comar, C.L. and Driggers, J.C., ibid, 109, 282 (1949).

(4) Spinks, J.W.T., Berlie, M.R. and O'Neil, J.B., ibid, 110, 332 (1949).

To be published in the Proceedings of the Society for Experimental Biology
and Medicine.

The present work was undertaken with the two-fold purpose of securing data to indicate the uptake of radioactive carbon in the egg and of obtaining from these eggs products of high enough specific activities to warrant their use in subsequent work. The isotopic carbon used was in the form of $\text{CH}_3\text{C}^{14}\text{OONa}$ and was mixed with the feed over a period of several days with a view to obtaining high activities in the eggs produced.

The radioactive carbon was incorporated into the shell, albumen and yolk of every egg laid during the experimental period.

Experimental Procedures: -- The sodium acetate- 1-C^{14} (9.55 millicuries, 0.787 g., sp. act. 12.1 $\mu\text{c}/\text{mg}$) was prepared by carbonation of methyl magnesium iodide with C^{14}O_2 (5).

(5) Calvin, M., et.al., "Isotopic Carbon", John Wiley and Sons, Inc., New York, 1949, p. 178.

The sodium acetate- 1-C^{14} was dissolved in a small amount of water and the resulting solution was sprayed over the feed (a practical laying ration) which was being stirred by hand. After all the solution was added, the feed was thoroughly mixed. The labeled acetate was administered in a total of three feedings. The first feeding comprised 4.78 mc. of acetate in 350 gm. of feed. Then 2.39 mc. of acetate in 175 gm. of feed and 2.38 mc. in 175 gm. of feed were fed on the sixth and eighth days, respectively, after the initial feeding. As soon as one portion of feed was exhausted, a new one was prepared and fed. Thus, the hen was fed labeled acetate for ten days, at which time she was sacrificed. The hen used was a Single Comb White Leghorn, maintained in a wire cage with a raised floor.

The shells were washed free of adhering matter and the yolk and albumen

of each egg was lyophilized separately. Each shell was freed of its shell membrane, which was lyophilized with the albumen, and then air dried and pulverized. Aliquots of the shell, yolk and albumen were converted by dry combustion to CO_2 , which was collected and counted as barium carbonate.

Seven eggs were collected over the ten day period of the experiment. The eggs were collected on the second, third, fourth, sixth, eighth, ninth and tenth days after feeding was begun. The hen was sacrificed on the tenth day and the contents of the ovary were separated into four fractions comprising two large ova, a number of easily separated small ova and the ovary with the remaining ova. Each of these fractions was homogenized, lyophilized and the activity of an aliquot was determined.

Results and Discussion: -- According to data presented in the book of Romanoff and Romanoff (6) the egg, in passing through the oviduct, spends

(6) loc. cit., p. 223 ff.

three hours in the albumen secreting region and nineteen hours in the uterus, where the shell is laid down. It is interesting to note that even in the first egg, which was laid within 24 hours after feeding was begun, radioactivity was present in the yolk, albumen and shell. This would indicate a very rapid metabolic utilization of the acetate, even for formation of albumen.

It is understandable that in the first egg most of the activity was found in the shell, since the radioactive carbonate was being produced from the acetate at the same time as it was being utilized for the formation of the shell. In the next two eggs the activity of the shell remained constant, here the acetate was being utilized at a steady rate. The activity of the fourth shell rose sharply. In this case, the shell was formed soon after

fresh feed was offered. The specific activities of the last three shells were roughly the same and were also of the same order of magnitude as that of the second and third shells. The carbonate for the last three shells and probably for the second and third appears to have been supplied from the metabolic pool.

The albumen of the first egg was of lower specific activity than the yolk, even though feeding was started at a time when deposition of the yolk was practically complete. This result might be expected, considering the possibility that for inclusion into albumen the acetate fragment or its carboxyl moiety would be required to traverse longer metabolic pathways than it would for inclusion into the shell or yolk. The further evidence that there was a sharp rise in the specific activity of the fifth albumen which was maintained in the sixth, in contrast to the rise in the activity of the shell and yolk of the fourth egg, seems to indicate a retarded incorporation of activity into the albumen. The low overall incorporation of activity into the albumen seems to reflect the rapid utilization of the acetate.

The yolks exhibit a specific activity variation that parallels that of the shells, with one exception which will shortly be noted. In the first yolk there was some incorporation of activity, albeit this yolk was almost wholly formed when the feeding was initiated; this is further evidence of the rapid utilization of the acetate. Yolks 2 and 3 showed a constant specific activity and yolk 4 shows a markedly higher activity due, presumably, to the continuous incorporation of activity from the metabolic pool. The fifth yolk, shows a marked decrease of specific activity from the $89 \times 10^{-4} \mu\text{c}/\text{mg}$. of yolk 4 to $30 \times 10^{-4} \mu\text{c}/\text{mg}$., the same order of magnitude as yolks 2 and 3 have shown.

Possible explanations for the low yolk activity of egg 5 are: (1) error in marking of the eggs and perhaps in combustion of the yolk or, (2) failure of the hen to ovulate this yolk at the normal time, that is, to have produced an egg on the fourth day between eggs 2 and 3. The latter explanation appears possible because the activities of the shell and albumen of egg 5 fit better into curves of the other eggs. No instances of such "held" yolks were found in the studies of Warren and Conrad (7).

(7) Warren, D.C. and Conrad, R.M., J.Agr.Research 58, 875 (1939).

Further investigation into the specific activities of various yolk fractions will indicate which of these possibilities is the more valid.

Yolks 6 and 7 exhibited a four-fold increase in specific activity over yolk 5; and yolk 6, which was formed closer to the beginning of the last feeding, showed a slightly higher specific activity than did yolk 7. The two large ova show specific activities of an order of magnitude comparable to those of yolks 6 and 7. It is evident that had the hen been allowed to lay these two eggs without further replenishing the radioactive principle in her diet their specific activities would have been lower. Based upon the average weight of the yolks obtained, the specific activities of yolks 8 and 9 would have been $75 \times 10^{-4} \mu\text{c}/\text{mg.}$ and $36 \times 10^{-4} \mu\text{c}/\text{mg.}$, respectively.

The data indicate that upon feeding of carboxyl-labeled sodium acetate, the activity is rapidly incorporated into all portions of the egg. The acetate is utilized immediately and a comparatively small percentage of radioactivity is diverted to the metabolic pool. Steady feeding of labeled material is required in order to maintain a high specific activity in all portions of the egg.

It is a pleasure to acknowledge the interest shown by Professors Melvin Calvin and Samuel Lepkovsky during the course of this work.

TABLE I

Weights and Activities of Collected Eggs and Ova*

Day	Acetate Fed	Egg	Total Activity of Egg	Shell		White		Yolk	
				Wt.	Act.	Wt.	Act.	Wt.	Act.
1	4780								
2		1	6.4	6.50	4.8	3.35	0.2	8.56	1.4
3		2	53.0	6.22	16.9	3.27	3.8	8.61	32.3
5		3	57.3	6.95	16.1	4.40	8.3	8.81	32.9
6	2390	4	115.5	6.13	33.4	4.08	6.8	8.48	75.3
8	2380	5	56.4	6.35	20.6	4.30	11.3	8.30	24.5
9		6	132.7	6.11	13.7	3.54	8.1	8.37	110.9
10		7	129.6	5.00	10.7	4.21	5.3	9.33	113.6
--		Ovum 1	64.8	--	--	--	--	5.85	64.8
--		Ovum 2	30.4	--	--	--	--	3.25	30.4
--		Ova	9.4	--	--	--	--	1.43	9.4
--		Ovary and Ova	10.5	--	--	--	--	2.44	10.5

* All weights of lyophilized solid, given in grams.

All activities as microcuries (μc).

TABLE II

Recovery of Radioactivity

	μc Recovered	% Total
Shells	116.2	1.21
Whites	43.8	0.46
Yolks	495.5	5.18
Ovary and Ova	10.5	0.11
Total	666.0	6.96

GRAPH 1
DISTRIBUTION OF TOTAL ACTIVITY
IN LAID EGGS

MU 1300

GRAPH 2
SPECIFIC ACTIVITY OF EGG FRACTIONS

MU 1299