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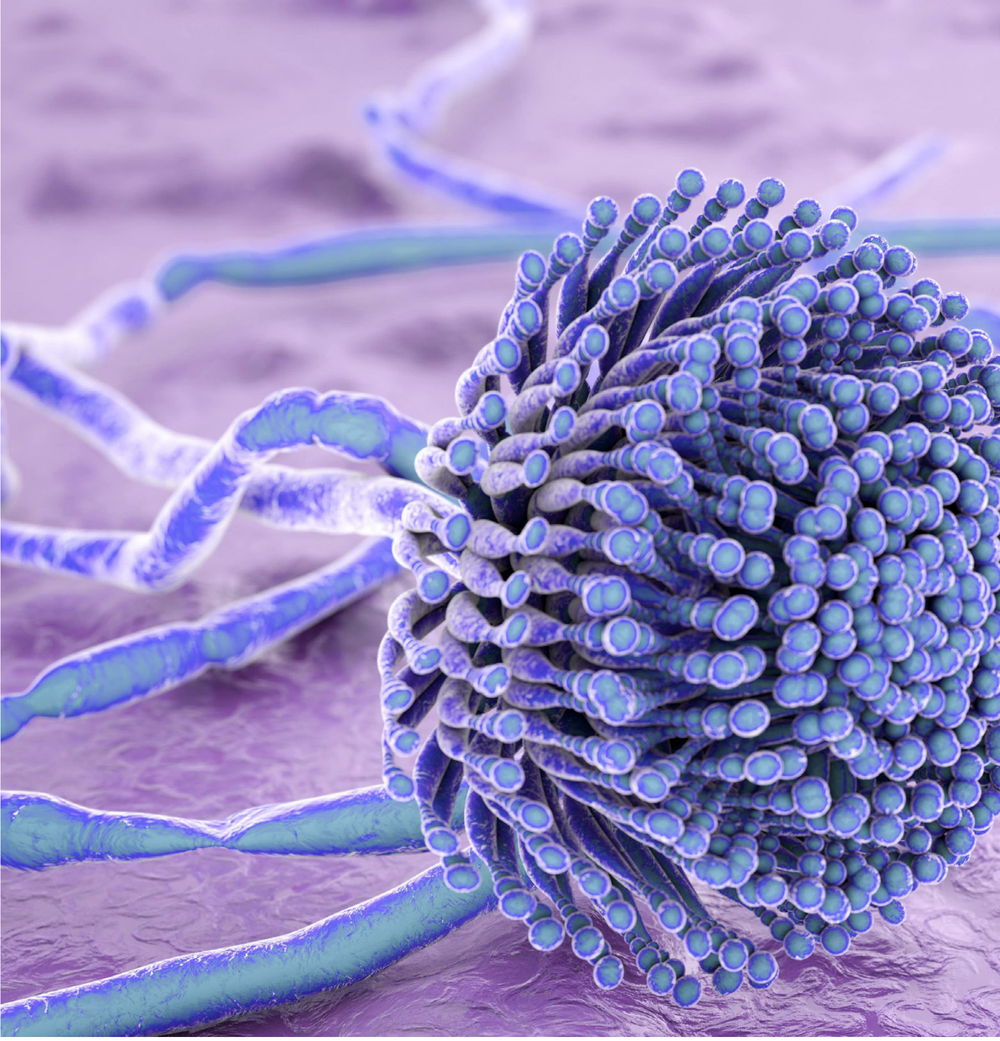

MYCOTOXINS IN DEVELOPING COUNTRIES: THE SILENT KILLER

BY ANDREA HE

E. coli. Pesticides. Salmonella. Mercury. These are dangerous food contaminants that in high quantities can cause detrimental health effects, not only in humans but also in animals. Food contamination has prompted protests, recalls, and removal of romaine lettuce, chicken, and fish from the shelves of grocery stores. However, mycotoxins are a relatively unknown type of food contaminant despite their global effects and their major impacts on developing countries. What steps should citizens take in order to improve human health?

THE HISTORY OF MYCOTOXINS

Mycotoxins are secondary metabolites produced by various types of mold and fungi and can cause a disease known as mycotoxicosis. The effects of mycotoxins range from mild to severe and are often specific to the organism by which they are produced. For example, aflatoxins, generated by the *Aspergillus* species of fungi, have carcinogenic effects.[1] Meanwhile, fusarial toxins from the *Fusarium* species can cause nervous system damage in horses and cancer in rats.[2] Humans most often ingest mycotoxins through foods such as cereal grains, milk, and meat. Due to livestock consumption of mold-contaminated foods, beef is a common source of mycotoxins in the human diet.[3]

Human interaction with mycotoxins has a lengthy history. Over 10,000 years ago, humans transitioned from a lifestyle of hunting and gathering to one of organized agriculture. This change necessitated the storage of food, especially grain, for longer periods of time.[4] Mold would strike when the grain rested in caves. Thus, to prevent mold, grain was stored on raised platforms or in silos where mold was less likely to reach it. In 800 A.D., during the Roman Empire, the government documented a case of what now appears to be mycotoxin poisoning, most likely caused by consuming rye contaminated with the mycotoxin ergot. Ergot can cause headache, diarrhea, and gangrene. Mycotoxin diseases such as this one may have been transmittable from a pregnant mother to her infant.[4] However, at the time, the Romans referred to the disease as "slow nervous fever." The name of the disease did not reveal the role of mycotoxins, as people did not realize these poisons existed.[4] These interactions between humans and mycotoxins are still present today.

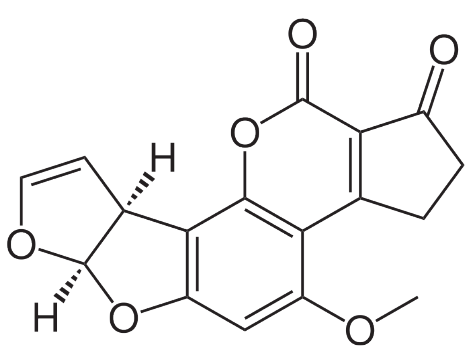

Figure 1: *Chemical strucure of aflatoxin B1.*

THE PROBLEM OF MODERN DAY MYCOTOXINS

Unfortunately, mycotoxins contaminate a large percentage of the world's food, especially grains. The Food and Agriculture Organization (FAO) of the United Nations has determined that 25% of the world's grain has been contaminated. This contamination can occur at many levels of production, from pre-harvesting to drying and storage.[5] Many countries have adopted methods to prevent contamination by applying innovative techniques, such as crop rotation, irrigation, and pesticide applications. For example, by shelling corn when it is harvested and improving grain storage techniques to minimize moisture, the United States has maintained extremely low mycotoxin levels in the nation's corn supply.[6] However, mycotoxins are still a prevalent problem in developing countries due to damaged and therefore inedible crops.[4] Improperly stored food increases susceptibility to mycotoxins, which drastically reduce the amount of food available to people.

Figure 2: *Corn affected by Aspergillus flavus fungus.*

DISPROPORTIONATE EFFECTS ON DEVELOPING COUNTRIES

Mycotoxin contamination disproportionately targets developing countries. Due to globalization and industrialization, many impoverished populations are growing less diverse crops, with a shift towards refined grain consumption. Refined grains have a higher susceptibility to mycotoxins than unrefined grains such as sorghum and cassava, both of which were previously consumed by residents of these countries. As a consequence of this change in the production of staple crops, citizens of developing regions in East Africa have higher risks of contracting mycotoxin-caused health problems. For example, researchers have noted similarities in the symptoms of mycotoxin contamination and autism. In humans, such symptoms include oxidative stress, inflammation, and intestinal permeability. These surprising findings are what encouraged scientists to investigate the effects of mycotoxins on the manifestation of autism.[7] By analyzing the role of ochratoxin A (OTA), a specific type of mycotoxin, researchers discovered that OTA is involved in the regulation of autism-related genes. Diets that are low in OTA and high in probiotics could ameliorate autistic symptoms in patients that are OTA positive.[7] Through findings like these, mycotoxins may shed light on a variety of other conditions. Mycotoxins can also impede the growth and development of children. This problem ultimately creates severe economic difficulties for countries such as India and Nigeria.[4]

> "Mycotoxin levels vary by country, and in order to optimize regulations and policies, countries need to have accurate data regarding mycotoxin levels."

In the developing country of Zimbabwe, further research is necessary to understand and address the problems that mycotoxins pose. Maize, which makes up 70% of the diet of Zimbabweans, commonly contains mycotoxins. Typical cooking methods in Zimbabwe do not reach high enough temperatures to kill the cells and spores within the food. Although the WHO and FAO of the United Nations have established upper limits for mycotoxin presence in food, relaxed regulations, droughts, and low funding often result in the failure of developing nations to observe and abide by these limits.[8] Consuming food with high mycotoxin levels is an ineffective means of resolving food shortages caused by droughts and poses serious long term health problems for the populations in developing countries.

ADDRESSING THE PROBLEM

In order to combat mycotoxin contamination in both developed and developing countries, investigators need to conduct more research. Limited funds and poor analytical equipment generally prevent journals from publishing papers by researchers in Zimbabwe.[9] Additionally, many researchers in developing countries are unable to afford the costs of publishing and conducting research.[8] Beyond research, policies that address the needs of developing nations need to be proposed and passed. Mycotoxin levels vary by country, and in order to optimize regulations and policies, countries need accurate data regarding mycotoxin levels. This kind of information can be difficult to obtain, especially since other issues such as vaccinations and HIV testing often take precedence. For this reason, publicizing the dangers of mycotoxins is important in allowing people to realize and address their impact.

Raising public awareness surrounding mycotoxin contamination through public health campaigns and social media may

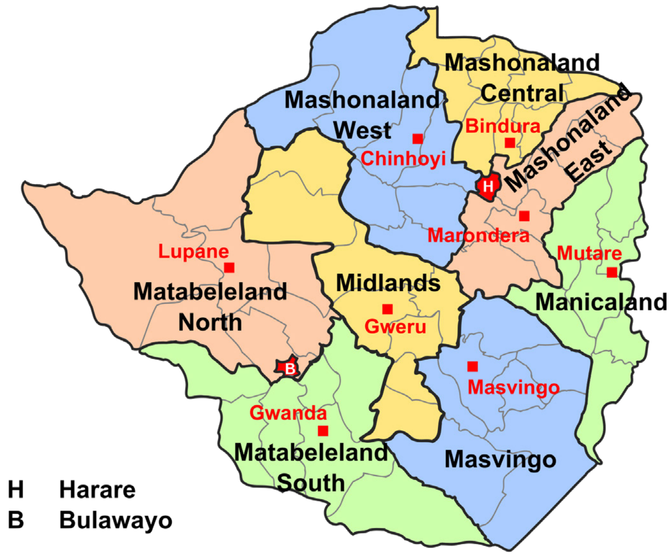

Figure 3: *Map of Zimbabwe.*

encourage the allocation of more funds to mycotoxin research. Furthermore, there is a strong need for countries to implement and enforce policies regarding mycotoxin contamination at the federal level. Model systems such as Good Agricultural Practices, Good Manufacturing Practices, and Good Hygienic Practices are researched and tested methods that can prevent mold and are a good starting points for policy development.[3] Hence, the combination of research and policy offers viable steps towards the prevention of food waste and the health of future generations.

REFERENCES

1. Cornely, O. A. (2008). Aspergillus to Zygomycetes: Causes, Risk Factors, Prevention, and Treatment of Invasive Fungal Infections. *Infection*, *36*(6), 605-606. doi:10.1007/s15010-008-9357-4.
2. Wild, C. P., & Gong, Y. Y. (2009). Mycotoxins and human disease: A largely ignored global health issue. *Carcinogenesis, 31*(1), 71-82. doi:10.1093/carcin/bgp26.
3. Heperkan, Z. (2006). The Importance of Mycotoxins and a Brief History of Mycotoxin Studies in Turkey. *ARI The Bulletin of the Istanbul Technical University*, *54*(4), 18-27.
4. Wild, C., Miller, J. D. & Groopman, J. D. (2016). Mycotoxin control in low-and middle-income countries. IARC Working Group Report No. 9. World Health Organization, Geneva, Switzerland.
5. Kabak, B., Dobson, A. D., & Var, I. I. L. (2006). Strategies to prevent mycotoxin contamination of food and animal feed: a review. *Critical reviews in food science and nutrition*, *46*(8), 593-619. https://doi.org/10.1080/10408390500436185.
6. Bennett, J. W., & Klich, M. (2003). Mycotoxins. *Clinical Microbiology Reviews, 16*(3), 497-516. doi:10.1128/CMR.16.3.497–516.2003.
7. De Santis, B. et al. (2017). Role of mycotoxins in the pathobiology of autism: A first evidence. *Nutritional neuroscience*, 1-13. doi:10.1080/1028415x.2017.1357793.
8. Smith, L. E., Prendergast, A. J., Turner, P. C., Humphrey, J. H., & Stoltzfus, R. J. (2017). Aflatoxin exposure during pregnancy, maternal anemia, and adverse birth outcomes. *The American journal of tropical medicine and hygiene*, *96*(4), 770-776. doi: https://doi.org/10.4269/ajtmh.16-0730.
9. Garwe, E. C. (2015). Obstacles to research and publication in Zimbabwean higher education institutions: A case study of the research and intellectual expo. *International Research in Education*, *3*(1), 119-138. doi:10.5296/ire.v3i1.7009.
10. Fung, F., & Clark, R. F. (2004). Health effects of mycotoxins: a toxicological overview. *Journal of Toxicology: Clinical Toxicology*, *42*(2), 217-234. https://doi.org/10.1081/CLT-120030947.
11. Nakajima, M. (2003). Studies on mycotoxin analysis using immunoaffinity column. *Mycotoxins*, **53**(1), 43-52. doi:10.2520/myco.53.43.
12. Nleya, N., Adetunji, M., & Mwanza, M. (2018). Current Status of Mycotoxin Contamination of Food Commodities in Zimbabwe. *Toxins*, *10*(5), 89. doi:10.3390/toxins10050089.
13. Pettersson, H. (2012). Mycotoxin contamination of animal feed. *Animal Feed Contamination*, 233-285. doi:10.1533/9780857093615.3.233.
14. Zinedine, A., Soriano, J. M., Molto, J. C., & Manes, J. (2007). Review on the toxicity, occurrence, metabolism, detoxification, regulations and intake of zearalenone: an oestrogenic mycotoxin. *Food and chemical toxicology, 45*(1), 1-18. https://doi.org/10.1016/j.fct.2006.07.030.
15. Wagacha, J. M., & Muthomi, J. W. (2008). Mycotoxin problem in Africa: current status, implications to food safety and health and possible management strategies. *International journal of food microbiology, 124*(1), 1-12. https://doi.org/10.1016/j.fct.2006.07.030.
16. Zinedine, A., Soriano, J. M., Molto, J. C., & Manes, J. (2007). Review on the toxicity, occurrence, metabolism, detoxification, regulations and intake of zearalenone: an oestrogenic mycotoxin. *Food and chemical toxicology, 45*(1), 1-18. https://doi.org/10.1016/j.fct.2006.07.030.

IMAGE REFERENCES

17. Kon, K. (n.d.). Black mold fungi *Aspergillus* [3D illustration, cover image]. Retrieved from https://www.123rf.com/photo_63439480_stock-illustration-black-mold-fungi-aspergillus-which-produce-aflatoxins-and-cause-pulmonary-infection-aspergillosis-3d.html.