Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 04, Issue: 03 (MAY-JUNE, 2024)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Aflatoxin in Feed Products: Impact on Human and Animal Health

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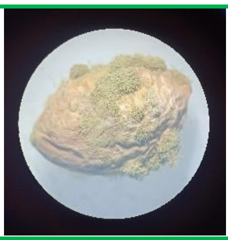
The mycotoxins produced by *Aspergillus* spp. are known as aflatoxins. Aflatoxins are commonly produced by *A. flavus* and *A. parasiticus*, but along with these some other species, such as *A. nomius*, *A. pseudotamarii*, *A. parvisclerotigenus* and *A. bombycis*; have also been reported as aflatoxin producers (Ahmad *et al*., 2014). Various types of aflatoxin have been identified, and their contamination in economically significant crops and food products is a major global issue (Luo *et al*., 2021). They are carcinogenic as well as mutagenic in nature and cause aflatoxicosis in both humans and animals (Kumar *et al*., 2017). Recently, a case of coronavirus disease linked with pulmonary aspergillosis have been reported. Pulmonary aspergillosis is known to exacerbate the severity of COVID-19 in immunocompromised patients. In total, 20 cases of Coronavirus disease-associated pulmonary aspergillosis (CAPA) have been reported worldwide (Marr *et al*., 2021).

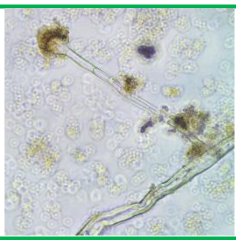
Currently, more than 18 different types of aflatoxins have been discovered, but the most common and important ones are aflatoxins B1, B2, G1, and G2. Their rampancy in food products makes them more important than the other types. Additionally, aflatoxin B1 binds with DNA and alters its structure, causing genotoxicity.

The infection of different crops with *A. flavus* may cause symptoms such as ear or boll rot, and yellow mould may also occur asymptomatically. *A. flavus* commonly infects maize, groundnuts, chili, cottonseed, and tree nuts during pre-harvest stages, while wheat, sorghum, and rice are more vulnerable during post-harvest stages. Improper handling and storage conditions of crops greatly influence the contamination of crops by *Aspergillus* spp. at the post-harvest stage (Callicott *et al*., 2018).

Abiotic factors such as temperature, water activity, pH, carbon, and nitrogen have a great influence on the aflatoxin biosynthesis pathway, but in particular, aflatoxin contamination is highly dependent upon temperature and water activity. These two conditions not only promote the growth of aflatoxin-producing fungi, primarily *A. flavus*, but also significantly influence the activation of the aflatoxin-producing gene cluster. Higher water activity favours better fungal growth and toxin synthesis.


A. flavus infected groundnut


A. flavus culture


Conidiophore of *A. flavus*

Impact on Human and Animal Health

Aflatoxins are considered not only hazardous for humans but also animals. They can cause different acute and chronic illnesses, which are discussed below.

Aspergillosis: Aspergillosis is a lung infection caused by *Aspergillus* species in immunocompromised individuals. It is caused by twenty different species of Aspergillus, with *A. fumigatus* and *A. flavus* being the primary culprits in humans and animals. Globally, most human aspergillosis infections result from excessive inhalation of *Aspergillus* spores. The second leading cause of infection is spore transmission through infected wounds, as well as smoking contaminated tobacco or marijuana. Various animals, including rabbits, chickens, turkeys, and geese, can also contract aspergillosis. Additionally, *A. flavus* is responsible for stone brood disease in honeybees.

Clinically, aspergillosis has different forms, which include extrinsic asthma, allergic bronchopulmonary aspergillosis, extrinsic allergic alveolitis, saprophytic pulmonary, and extra-pulmonary colonizing, as well invasive pulmonary and extrapulmonary aspergillosis (Amaike and Keller, 2011). Allergic bronchopulmonary aspergillosis (ABPA) accumulates in 1–15% of the world's population already infected with cystic fibrosis and also in 2.5% of asthma patients, which in total comprises 4.8 million people globally.

Aflatoxicosis: Aflatoxicosis refers to poisoning resulting from the significant consumption of *Aspergillus* species, primarily *A. flavus*, through spores or contaminated food. This can lead to chronic or acute aflatoxicosis in humans and animals. Chronic aflatoxicosis can cause liver cancer, human hepatic cell carcinoma, stunted growth, reduced immunity, and cirrhosis in malnourished children. Acute aflatoxicosis is characterized by high fever, vomiting, ascites, liver failure, foot edema, and jaundice, and has a higher mortality rate than chronic aflatoxicosis. Accurate values of the aflatoxin concentration that causes aflatoxicosis have not been confirmed; however, with the help of a few studies, it is estimated that generally 1000 g/kg of aflatoxin concentration in food can cause aflatoxin toxicity in humans (WHO, 2018).

Cancer: Aflatoxins are reported as a Group 1 carcinogen and their long-term exposure may cause kidney, liver, lung, or colon cancer in both animals and humans. In Africa and Asia, the primary liver cancer known as hepatocellular carcinoma is related to aflatoxin B1, while about 4.6–28.2% of hepatocellular carcinoma around the world is reported to be caused by aflatoxin consumption. Moreover, aflatoxin B1, which is characterized as a Group 1 carcinogen, is found to be hazardous if a concentration of 20–120 g/kg is consumed per day for 1 to 3 weeks. However, the extent of aflatoxin toxicity highly depends upon the immunity of the host. Hepatocellular carcinoma (HCC) is the major outcome of aflatoxin exposure and is the cause of 75–85% cases of liver cancers worldwide. Furthermore, 1480 new cases of liver cancer due to aflatoxins were identified in Tanzania in 2016 (Kimanya *et al*., 2021).

Conclusions

Aflatoxins are secondary metabolites produced by different species of *Aspergillus*, more specifically *A. flavus* and *A. parasiticus*, that are carcinogenic and toxic. Research on aflatoxins began in the late 1950s and early 1960s. Since then, numerous studies and discoveries have expanded our understanding of aflatoxins. To date, 18 different types of aflatoxins have been identified. New and advanced technology has also enabled mankind to study the structure of aflatoxins and their biosynthesis pathways utilizing different methods, which can be used to detect them at early stages. Several management strategies have also been deployed for the control of these aflatoxins worldwide. This review will assist researchers devise mitigation strategies, based on the information shared in this article.

References

1. Ahmad, M.M., Ahmad, M., Ali, A., Hamid, R., Javed, S. and Abdin, M.Z. (2014). Detection of *Aspergillus flavus* and *Aspergillus parasiticus* from aflatoxin-contaminated peanuts and their differentiation using PCR-RFLP. *Ann. Microbiol*., 64, 1597–1605.
2. Amaike, S. and Keller, N.P. (2011). *Aspergillus flavus*. *Annu. Rev. Phytopathol*., 49,107–133.

3. Callicott, K.A., Kachapalula, P., Edmunds, D., Singh, P., Jaime, R., Islam, M.S., Shenge, K., Adhikari, B.N., Arone-Maxwell, L., Ching' and a, C., *et al*. (2018). Brief protocols for research on management of aflatoxin-producing fungi, 2nd ed.; ARS, USDA: Phoenix, AZ, USA.
4. Kimanya, M.E., Routledge, M.N., Mpolya, E., Ezekiel, C.N., Shirima, C.P. and Gong, Y.Y. (2021). Estimating the risk of aflatoxin-induced liver cancer in Tanzania based on biomarker data. *PLoS ONE*, 16,247281.
5. Kumar, P., Mahato, D.K., Kamle, M., Mohanta, T.K. and Kang, S.G. (2017)**.** Aflatoxins: A global concern for food safety, human health and their management. *Front. Microbiol*., 7,2170.
6. Luo S., Du, H., Kebede H., Liu Y. and Xing, F. (**2021).** Contamination status of major mycotoxins in agricultural product and food stuff in Europe. *Food Control*, 127, 108120.
7. Marr K.A., Platt A., Tornheim J.A., Zhang S.X., Datta K., Cardozo C. and Garcia-Vidal, C. (2021). Aspergillosis complicating severe coronavirus disease. *Emerg. Infect. Dis*., 27, 18–25.
8. World Health Organization (WHO). Aflatoxins; WHO: Geneva, Switzerland, 2018. Available online: https://www.who.int/foodsafety/FSDigest_Aflatoxins_EN.pdf