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Review Article

Global Public Health and Economic Concern due to Aflatoxins

*Mahendra Pal[1], Adugna Girma Lema[2], Iyasu Ejeta Dame[3] & Leena Gowda[4]

[1]Founder Director of Narayan Consultancy on Veterinary Public Health and Microbiology, Anand, Gujarat, India
[2]Yemalogi Welel Woreda Livestock and Fishery Development and Resource Office, KellemWollega Zone, Oromia, Ethiopia
[3]Meta RobiWoreda Livestock and Fishery Development and Resource Office, west ShoaZone, Oromia, Ethiopia
[4]Department of Veterinary Public Health and Epidemiology, KVAFSU, Veterinary College, Hebbal, Bangaluru-560024, India

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***Corresponding author:** Prof. Dr.Mahendra Pal

Abstract

Mycotoxins are recognized as silent killers of humans and animals including the poultry, and reported from developing as well as developed nations of the world. Presently, more than 350 mycotoxins are produced by fungi, which occur as saprophytes in nature. The formation of mycotoxins in nature is considered a global problem. The ingestion is the prime portal of entry of mycotoxins in the body. Mycotoxins have carcinogenic, teratogenic, and immunosuppressive effects on living host. Four major types of aflatoxins have been reported among this AFB1, the most potent naturally occurring mutagen, is of particular concern because it is a frequent contaminant of many food products and which has a direct link to human liver cancer. Aflatoxins are regularly found in agricultural products, posing major health risks to the plants, humans, and domestic animals. This has become a growing issue in recent years. They are natural contaminants of foods; their development is unavoidable; hence, it is critical to chemically or physically detoxify tainted crops of foods in methods that preserve their edibility. Aflatoxicosis can occur in both acute and chronic forms. Acute aflatoxicosis causes death, whereas chronic aflatoxicosis produces pathologic changes that last longer, such as cancer and immunosuppression. The crop and livestock losses are one source of economic losses, but there are also costs associated with regulatory compliance. This review is useful for health-conscious consumers and researchers interested on the impact of aflatoxin on public health and its economic relevance.

Keywords: Fungal Metabolites, Mycotoxins, Public health, Aflatoxins, Contamination, Economic significance

INTRODUCTION

Mycotoxins are toxic secondary metabolites produced by fungi in agricultural goods susceptible to mold infections. Their fungal origin, chemical structure, and biological activity help to distinguish those[1]. Because of the tendency to contaminate the human food and animal feed, especially the cereals, nuts, and oilseeds, mycotoxins are of economic and health significance. Mycotoxins are among the microbial toxins of most concern to public health, and they pose a barrier to a wider worldwide trade in agri-food products and an essential challenge in the face of the harmonization of regulatory requirements globally[2]. Mycotoxins are mainly produced by three most predominant genera of the fungi, such as *Aspergillus, Fusarium* and *Penicillium*[3,4,5,6]. The exposure to mycotoxins can occur through ingestion, inhalation, and direct contact[5]. Natural cases of mycotoxicosis have been described in humans and also in many species of animals such as buffalo, cattle, dog, duck, fowl, horse, mouse, pheasant, pig, quail, rabbit, rat, sheep, and turkey[4,5,6]. The importance of mycotoxins as silent killers of humans and animals is delineated by Pal in 2017[6].

Presently, over 350 mycotoxins have been discovered in nature, but aflatoxins are the most well-known and important from public health and economic point of view [4, 6]. Aflatoxins are a series of related fungal secondary metabolites principally generated by the fungus namely *Aspergillus flavus* and *Aspergillus parasiticus*[4,7,8]. However, other species of *Aspergillus*, namely *A. nominus*, *A. ochraceroeus* and *A. pseudotamarii* can also produce aflatoxins[9]. Aflatoxins are secreted in favorable conditions throughout their growth[4,10]. Aflatoxinsare introduced into the animal source food chain when animal feeds are infected with aflatoxin producing fungus. Humans and animals can become ill or die as a result of polluted agricultural items[10]. Aflatoxin has been reported to occur in a wide variety of commodities like cheese, almonds, pistachios, peanuts, figs, maize, rice, spices, milk, bread, egg, fish, and[3,5,6,11]

Aflatoxins are naturally occurring food pollutants. Since the 1960s, agricultural producers have recognized aflatoxins as important pollutants, and control efforts in industrialized countries have largely removed dangerous exposures[1].There are 20 different aflatoxin reported among this B1, B2, G1, and G2 are the most prevalent naturally occurring aflatoxin, while M1 and M2 are metabolic products of contaminated food or feed and are present in milk and other dairy products [12]. Under ultra violet (UV) light, the B1 and B2 forms of aflatoxins emit a strong blue fluorescence, whereas the G1 and G2 forms emit a greenish yellow fluorescence. Aflatoxin B1 and B2 are produced by *Aspergillus flavus*. Cycloponic acid, kojic acid, nitropropionic acid, aspenoxin, aflam, and aspergillic acid are some of the other toxic compounds produced by *A. flavus*. In addition to B1 and B2, *A. parasiticus* produces aflatoxin G1 and G2, but not cyclopionic acid. The most dangerous type of aflatoxin is B1, which has a direct link to human liver cancer[13]. The purpose of this review is to provide an update information on public health and economic importance of aflatoxins.

Threat of Aflatoxin on human and animal health

Humans can be exposed to aflatoxins by eating foods contaminated with the toxin or by eating the products like milk, cheese, meat, egg, and fish produced by animals that have been exposed to aflatoxins[14]. Aflatoxins can cause deleterious effects on various organs of the body including the liver, kidney, spleen, and others. The liver is the main target organ in aflatoxicosis. It is stated that aflatoxicosis can occur in sporadic as well as in epidemic form[4].The effect of aflatoxins can be manifested in acute and chronic form. Acute aflatoxicosis causes death, whereas chronic aflatoxicosis causes pathologic changes that last longer, such as cancer and immunosuppression[4]. It is important to mention that aflatoxin can cause damage to DNA[15]. Aflatoxin is the most toxic and has the greatest impact on animal and human health as well as financial loss[16]. The outbreaks of aflatoxicosis have been reported from many countries including India [4,17,18].A massive outbreak of hepatitis with an estimated 106 deaths of tribal people due to consumption of aflatoxin contaminated maize was reported in 1974 in the Indian states(Gujarat and Rajasthan)[19]. Aflatoxin B1 presence at livestock feed produces numerous difficulties in genital, digestive and respiratory systems through different processes, such as interference in metabolism of carbohydrates, lipids and nucleic acids. Effects of aflatoxin B1 on livestock vary with concentration and time duration of contact with the toxin, strain and diet. High quantities of this toxin are deadly, medium concentrations cause chronic poisoning, and low concentrations can cause liver cancer if exposed to them repeatedly[20].The outbreaks of aflatoxicosis have been described in several species of animals including calves, dogs, pigs, rabbits and turkeys[4]

Because around one-fifth of eaten aflatoxin B1 is introduced into milk as aflatoxin M1, and different heat treatments used in the preparation of various dairy products cannot lower the amount of aflatoxin M1, there is always the risk of becoming sick from ingesting the infected milk. Aflatoxin M1 has a lower capacity for tumor genesis and mutagenesis than aflatoxin B1[21].

Acute aflatoxicosis has a wide range of human health implications, from death to aggravated hunger, all of which are devastating to the affected populations. When breastfeeding animals consume aflatoxin contaminated feed, aflatoxin metabolites are excreted in the milk. Aflatoxin producing fungi inthe milk can induce aflatoxicosis. However, no action is taken until the aflatoxin level in market milk exceeds 0.5 ppb, the limit at which the public is not at risk. For cattle, "action levels" refer to the degree of contamination at which the feed could be harmful to their health or cause contamination ofmilk,meat,oreggs[22]. Aflatoxin exposure from consuming contaminated food has been associated to stunting growth in children. However, the exact mechanisms underlying these effects of aflatoxins have not been elucidated[23].

Experiments in China and African areas with a high incidence of hepatitis B infection, when dietary exposure to aflatoxin was common, have shown that aflatoxin has a negative influence on health. Aflatoxin exposure is ubiquitous in West Africa, likely beginning in utero, and blood tests have revealed that a large percentage of West Africans are exposed to aflatoxins. Over 98 percent of participants tested were foundpositive for aflatoxin markers in a study conducted in Gambia, Guinea Conakry, Nigeria, and Senegal [24]. Another major complication that can arise from eating aflatoxins-contaminated food is cancer. Aflatoxin B1 is the most potent and commonly occurring of the aflatoxins B1, B2, G1, and G2, which have been classified as group I carcinogens and are thought to be the cause of hepatotoxicity in developing countries [25]. Aflatoxin B1 has also been identified as a teratogen, mutagen, hepatocarcinogen, immunosuppressant, and a potent inhibitor of protein synthesis [25].

Economic significance due to aflatoxin

Aflatoxism's economic impacts are a key source of frustration. Animal productivity and trade are both harmed by aflatoxins. When vulnerable animals are fed contaminated foods, their growth rates are lowered, they become unwell, and they die; also, their meat and milk may include harmful biotransformation products. Farmers and feed businesses are frequently sued by livestock owners, and legal fights can be costly[26].

The direct economic impact of aflatoxin contamination in crops is primarily due to a decrease in marketable products as a result of product rejection from the international market, as well as losses incurred from livestock disease, consequential morbidity and mortality, which results in volume and value loss in national markets, resulting in significant economic loss [27].

The annual cost of mycotoxins in Canada and the United States is estimated to be $5 billion [6]. Aflatoxin-related concerns cost maize farmers in the United States $160 million each year. These statistics are greater in developing nations, particularly in Sub-Saharan Africa, where losses total $450 million, accounting for 38 % of global aflatoxin-related agricultural losses [28].

According to the World Bank, EU policy changes will lower imports of cereals, dried fruits, and nuts from African nations such as Chad, Egypt, Gambia, Mali, Nigeria, Senegal, South Africa, Sudan, and Zimbabwe by 64 %, costing African countries US$670 million in trade each year [29].

Conclusion and Recommendations

Food has always played a crucial part in a country's rise or collapse. Foodborne diseases are caused by eating tainted or hazardous food, and may cause significant morbidity and mortality throughout the world. Aflatoxin poisoning of foods and feeds is a severe global problem caused by inappropriate commodity storage or contamination prior to harvest. As a result, contamination is a global food security issue, particularly in developing nations where food freedom is limited.

The presence of aflatoxin in food and animal feed is a serious issue in terms of food and feed safety. The impact on human and animal health has resulted in significant economic losses. The threat of contamination in food commodities follows the dosage-to-response laws and is linked to health risks in both animals and humans. They also receive more attention than other mycotoxins due to their potent acute toxicological and carcinogenic effects in susceptible animals and humans, as well as the economic impact resulting directly from crop, livestock, and product losses, and indirectly from the cost of regulatory programs aimed at reducing animal risks. Lack of sanitary precautions on food products contaminated with aflatoxins, mold development is unavoidable and aflatoxins can pass through manufacturing and cooking procedures.

Following are some recommendations based on the above conclusion:

- Using hygienic measures, natural aflatoxins in the food chain should be decreased.
- It is critical to raise public awareness about aflatoxins and their toxicity in order to safeguard people from their detrimental impacts.
- There is a need to develop advanced methods or kits for detecting trace levels of aflatoxin in food and food products.
- It is emphasized that all the food items must be regularly monitored for the level of aflatoxin in order to protect the health of the consumers.
- Future research should be conducted to create adequate technologies for aflatoxin quantification, precise detection, and control in order to assure the safety of consumers' health.

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Contribution of Authors
All the authors contributed equally. They read the final version, and approved it for the publication.

Conflict of Interest
The authors declare that they do not have conflict of interest.

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