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Multi Dimensions of Mycotoxins, Its Cause, Effect and Management

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INTRODUCTION

Basically, mycotoxins are secondary metabolites produced by a variety of molds on several agricultural commodities under specific environmental conditions. The term mycotoxin was first used in the 1960s to describe the toxin associated with contaminated peanuts in animal feed and the loss of turkeys in England and the disease was named as Turkey X disease. This mycotoxin was later identified as the *Aspergillus flavus* toxin AflatoxinB1 (Bean & Echandi, 1989). A broad spectrum of acute and chronic diseases in livestock is due to mycotoxins, whichcan remain as a residue in meat and milk, posing a possible threat to human health. The amountand type of mycotoxin varies with environmental conditions such as temperature and humidity.

Contrastingly, these are a structurally different group of fungal natural products that share the ability to cause harm to vertebrate animal or human health when they are contaminants of animal feed or food. A primary inoculum of the fungus onto the feed is necessary for the fungus to develop, but abundant spores are usually present in soil, air and water. The toxigenic fungal spores are ubiquitous in nature. They can germinate, grow and elaborate their toxins into a variety of substrates when conditions of moisture, temperature and aeration are favorable. The optimal conditions for toxin production by different fungi may be quite variable from one to other.

On contrary, the mycotoxins of major concern are the aflatoxins, ergot, trichothecenes (including deoxynivalenol (DON), nivalenol (NIV), T-2 toxin and HT-2 toxin), patulin, citreoviridin, ochratoxin, the fumonisins (FB) predominantly fumonisin B1 (FB1), zearalenone(ZEN), the ochratoxins, predominantly ochratoxin A (OA) and vomitoxins. Whereas, aflatoxins (AF) are of major concern in food and feedstuffs imported from warmer tropical and subtropical regions.

VARIOUS MYCOTOXINS THAT AFFECT HUMANS AND CATTLE ARE:

Aflatoxins:

Effects in humans:

The deuteromycete fungus *Aspergillus flavus* produces the mycotoxin known as aflatoxin on a number of crops including cotton, peanut and corn. Different types of aflatoxin are produced by the fungus. Among all the mycotoxins Aflatoxin B1 is considered to be the most toxic and is produced by both *Aspergillus flavus* and *Aspergillus parasiticus*. Aflatoxin G1 and G2 are produced exclusively by *A. parasiticus*. The main effects of aflatoxin are related to liver damage called as cirrhosis. If the dose is sufficient to produce an acute toxicity, it results in an increased clotting time and hemorrhage, especially in the intestinal lumen.

In sub-acute cases of poisoning, the liver lesions are those of regeneration and repair rather than cell necrosis. The bile duct cells proliferate and scar tissue forms. The rate of protein formation and the growth rate are depressed but the animal may not die. In chronic cases, the lesions are those of chronic liver dysfunction. These usually include icterus, fibrosis or cirrhosis of the liver, ascites and pulmonary edema. The changes may be so subtle that they are overlooked, but it can result in decreased appetite, poor feed conversion, reduced growth rate and decreased resistance to disease. It may also cause diarrhea, bloody diarrhea, abortion, or deformities of the fetus.

Effect on animals:

In case of young animals are usually more sensitive than are older ones. In calves, 150–200 ppb (or 0.5 mg/day) results in unthrifty animals. It would require 300–400 ppb to cause first calf heifers to lose weight and 2400 to 3100 ppb to reduce the appetite and markedly decrease production of adult dairy cows. However, 10,000–12,000 ppb (10–12 ppm) would cause the death of an adult cow in about five days. Even lower levels may have an effect in the farm situation, compared to when a purified toxin is used in the laboratory. This is evidently due to the synergistic effects of other molds and their products in the farm situation. Apart from cattles, even the Human exposure to aflatoxin can result from direct consumption of aflatoxin contaminated foods, whether processed or unprocessed. Aflatoxin ingested by food producing animals may also be transferred within the animal's body into meat, milk, or eggs and these would be potential sources for human exposure. Aflatoxin contaminated foods are deemed adulterated.

ERGOT:

Ergot alkaloids are compounds produced as a toxic mixture of alkaloids in the sclerotia of species of *Claviceps*, which are common pathogens of various grass species. There are two forms of ergotism: gangrenous, affecting blood supply to extremities, and convulsive, affecting the central nervous system. Modern methods of grain cleaning have significantly reduced ergotism as a human disease, however it is still an important veterinary problem. Ergot alkaloids have been used pharmaceutically. Ergot is the sclerotium (resting stage) of parasitic ascomycetes of the genera *Claviceps*, notably *C. purpurea*, (*Clavicipitaceae*), which replace the seeds of susceptible grasses, commonly rye (*Secale cereale* L.).

TRICHOTHECENE:

The yellow controversy: Trichothecenes belong to a very large family of chemically related mycotoxins. The trichothecene mycotoxins is used as biological weapon in Southeastern Asia. It is commonly called as "yellow rain". Which is producedby *Fusarium*, *Myrothecium*, *Trichoderma*, *Trichothecium*, *Cephalosporium*, *Verticimonosporium* and *Stachybotrys spp*. Trichothecenes belong to sesquiterpene compounds.

DEOXYNIVALENOL (DON): It is commonly called as Vomitoxin, it is a type B Tricothecene. This occurs predominantly in cereals *viz*., barley, wheat, oats, rye etc., it is primarily associated with the *Fusarium graminearum* and *F. culmorum* which causes fusarium head blight in corn. These are the

strong inhibitors of protein synthesis, exposure to this toxin causes the brain to decrease the uptake of the amino acid and in turn the synthesis of tryptophan. Large consumption of vomitoxin pose acute toxicity in humans.

NIVALENOL (NIV): It is a sub group of trichothecene group. It is commonly found in fungi of the *Fusarium graminearum* species. The history of nivalenol dates back to 1946-63, intoxication of Fusarium infected grains caused intoxication in humans and cattles.

PATULIN

It is a potent protein synthesis inhibitor and is also regarded as genotoxic. In animal toxicity studies, the effects observed include reduced weight gain, impaired kidney function and intestinal effects.

CITREOVIRIDIN

It is a neurotoxin in animals, resulting in paralysis and muscular atrophy.

OCHRATOXIN

Ochratoxin is a mycotoxin that comes in three secondary metabolite forms, A, B, and C. it is named after the species which produces it *i.e.*, *Aspergillus ochraceus* and some mycotoxins are also produced by *penicillum* species. The three forms differ in that Ochratoxin B (OTB) is a non-chlorinated form of Ochratoxin A (OTA) and that Ochratoxin C (OTC) is an ethyl ester form Ochratoxin A. *Aspergillus carbonarius* is the main species found on vine fruit, which releases its toxin during the juice making process. OTA has been labeled as a carcinogen and a nephrotoxin, and has been linked to tumors in the human urinary tract, although research in humans is limited by confounding factors.

ZEARALENONE

It is an oestrogenic substance with relatively low overall toxicity but it has been shown to have uterotrophic (anti-reproductive) effects in pigs. The effects of this mycotoxin in humans are not clearly established.

TREATMENT

Basically efforts of treatment are directed to removal of the contaminated feed and good nursing care of the animals. All surgical procedures should be delayed until the liver function and blood clotting mechanisms have returned to near normal.

DETECTION OF MYCOTOXINS

The techniques used for detecting the known mycotoxins are quite advanced and range from methods for directly detecting the toxins themselves based upon their physical characteristics, indirectly through immunoassays. The methods like physicochemical methods such Gas chromatography (GC), High performance liquid chromatography (HPLC), Thin layer chromatography (TLC), Enzyme linked immune sorbent assay (ELISA), Radio-immunoassay(RAI).

AFLATOXIN LEVEL FOR HUMAN AND ANIMAL CONSUMPTION

Aflatoxin concentration	Affects on animal health
20 ppb	Highest level allowed for humans
50 ppb	Highest level allowed for animals
100 ppb	Slowed growth of young ones
200-400 ppb	Slowed growth of adults
>400 ppb	Liver damage and cancer

Lava Kumar et al. 2009

CONCLUSION

The mycotoxins though shows effect on both Humans and Cattles, it is said to be harmful only when the amount of it increases than the normal. So, anything which is in normalis said to be feasible for the consumption. And if it exceeds the normal proper detection and treatments should be taken up to diagnose and several management methods have to be taken to reduce the toxin levels of the fungus in the food commodities. These management methodscan be single or integrated in order to reduce the effects of the mycotoxins.

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