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MYCOTOXIN CONTAMINATION IN CATTLE FEED AND FEED INGREDIENTS

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INTRODUCTION

Livestock production is an important part of national economy and it plays a significant role in providing the high quality food for human beings. Dairy industry of Pakistan contributes up to 46.8% in the agriculture and about 10.8% of the GDP in the form of milk, milk products, meat, hides, skin and bone meal (Anonymous, 2007). The role of livestock sector in enhancing agricultural productivity is well recognized and its contribution to alleviate poverty in rural areas is enormous (Abedullah *et al*., 2009). Various stresses like low quality feed, naturally occurring toxic contamination in feed stuffs, poor management, diseases, climatic extremes and other constraints are ever present threats that can adversely affect performance and health of animals. Cattle feed is at a risk of contamination from activities of insects and microbes. Microbes like bacteria, viruses, yeast and fungi invade the feedstuff and produce toxic compounds (i.e. endo or exotoxins and mycotoxins) which are detrimental for the health of dairy cattle.

In the past, most investigations have focused on bacterial or viral diseases in cattle, whereas mycotoxins were only studied in monogastric animal species like poultry and pigs. Mycotoxins, being the insidious poison in comparison with the classic bacterial toxins (which produce characteristic symptoms within a few hours after ingestion), have been overlooked in the past. Another dilemma associated with the effects of mycotoxins in ruminant is based on the paradigm that ruminants are relatively tolerant to adverse effects of mycotoxins, presumably due to ability of rumen microflora to detoxify the mycotoxins. According to the recent studies, it was observed that some of the rumen metabolites are more toxic than parent mycotoxins i.e. conversion of zearalenone to α-zearanol (Kiessling *et al*., 1984). Secondly, mycotoxins impair ruminal functions by exerting antimicrobial effects on rumen microflora. Thirdly, increased rate of passage of feed through the rumen may possibly overwhelm the ability of the rumen to completely denature the toxins (Gremmels, 2008).

Mycotoxins are toxic, chemically diverse secondary substances or metabolites produced by a wide range of fungi. There are over 100 species of fungi that can infect plants and produce mycotoxins. Mycotoxins are mainly produced by Aspergillus, Penicillum and Fusarium genera (Akande *et al.,* 2006). Infections by mold and mycotoxin production can develop at various stages of crop production: in the field, during harvesting and transportation or storage (Martins *et al.,* 2007). Researchers divide fungal species into two groups: field fungi and storage fungi. Field fungi are those which invade the plant while the crop is still in the field and storage fungi are those which invade the grains during their storage. Factors that influence the mycotoxin production include: temperature, moisture, oxygen, substrate aeration, inoculums concentration, microbial interaction, mechanical damage and insect infestation. Toxigenic fungal spores are present everywhere in soils, air and water. When conditions are favourable, they can germinate, grow and produce the toxin (CAST, 2003).

Cattle feed is a concentrate, basically comprising cereals and usually by-products of plants and animal sources and this concentrate is then mixed with green fodder. Due to high feed cost, mixing of stale bread, kitchen and bakery wastes in the feed are in practice. These waste products are usually tainted with fungus and may be a contributing factor in mycotoxin production in cattle feed. A catastrophe occurred in Karachi in Landhi cattle colony in 2007, in which 493 animals died and 1200 animals fell sick and the report released by Pakistan Council for Scientific and Industrial Research (PCSIR) Karachi has concluded that death was caused by a high concentration of aflatoxin and T-2 toxin in the cattle feed (Ilyas, 2007). Since Pakistan has cool, hot and humid type of environment, the chances of occurrence of important and major mycotoxins like aflatoxin, zearalenone, trichothecenes, ochratoxin and fumonosins are more likely in the cattle feed. Mycotoxins can cause damage to organ systems, reduce production and reproduction, and increase diseases by reducing immunity. Some mycotoxins are carcinogens, some target liver, kidney, digestive tract or the reproductive system (Akande *et al*., 2006). The harmful effects of some mycotoxins in buffaloes and cows are given in Table 1.

Table 1: Mycotoxins and their effects on buffaloes and cows

Effects	Mycotoxin
Immune suppression	Aflatoxin, trichothecene
Hepatotoxicity	Aflatoxin, fumonosin
Carcinogenicity	Aflatoxin, fumonosin
Nephrotoxicity	Ochratoxin
Neurotoxicity	Trichothecene
Decreased performance	Aflatoxin, trichothecene, zearalenone
Hematopoiticity	Trichothecene
Dermal effects	Trichothecene
Teratogenic effects	Aflatoxin, zearalenone
Gastrointestinal effects	Aflatoxin, trichothecene

Aflatoxins

Aflatoxins are the fungal metabolites produced by some strains of *Aspergillus flavus* and *Aspergillus parasiticus.* Aflatoxin is produced at a temperature of 12-40°C and requires 3-18% moisture (Duncan and Hagler, 2008). The four most common aflatoxins are B_1, B_2, G_1 and G_2, with the B_1 most potent liver toxin (Zinedine and Manes, 2008) and classified as class I carcinogen for humans by IARC (1993). In animals, their effects vary with the dose, length of exposure, species, breed, diet or nutritional status. Generally, calves are more susceptible than older animals. It exerts carcinogenic, teratogenic, hepatotoxic and mutagenic effects and also suppresses the immune system of cattle. Aflatoxins exert acute and chronic effects in animals (Aydin *et al*., 2008). It may cause liver damage, cancer, drop in milk production, immune suppression and anemia. Furthermore, it is also associated with reduced feed consumption and overall retarded growth and development in dairy cattle (Akande *et al.,* 2006). When cows were fed with an aflatoxin free diet, milk production increased over 25% (Guthrie, 1979). Aflatoxin is excreted into milk within 12 hours in the form of aflatoxin M_1 with residues approximately equal to 1.7% of the dietary aflatoxin level. The FDA limits for aflatoxin M_1 in milk is 0.5 ppb and for aflatoxin B_1 should not be more than 20 ppb (Diaz *et al.,* 2004).

Trichothecenes

Trichothecenes are a group of over 180 structurally related sesquiterpenoid mycotoxins produced by Fusarium on basic commodities used in animal food and feed (Zinedine and Manes, 2008). Trichothecenes are known to cause problems in dairy animals and include T-2 toxin, HT-2 toxin, deoxynivalenol, diacetoxyscirpenol and nivalenol. These are associated with reduced feed consumption, decreased milk production, absence of estrous cycle, production losses, gastroenteritis, intestinal haemorrhages and necrosis (Mann *et al*., 1983). Dietary T-2 toxin at a level of 640 ppb for 20 days can cause bloody faeces, enteritis, abomasal and ruminal ulcers which ultimately lead to death (Pier *et al*., 1980). They are also known to suppress immunity, interfere with protein synthesis, toxic to kidney, lymphoid tissue and for bone marrow (Gentry *et al*., 1984). In cattle, deoxynivalenol (DON) has been associated with reduced feed intake, lower milk production, elevated milk somatic cell counts and reduced reproductive efficiency when diet contains more than 300 ppb of DON (Jones *et al*., 1994).

Zearalenone

Zearalenone is an estrogenic metabolite of several species of Fusarium and occurs mainly in silage, corn and other grains such as soybean, wheat barley, oats, sorghum, seasame seed and hay in many areas of the world and its occurrence depends upon seasonal weather conditions (Saforza *et al.,* 2006). It elicits an estrogenic response and is associated with abortion in cattle, vaginitis, vaginal secretion, poor reproductive performance and mammary gland enlargement (Jones *et al.,* 1994). Diet with about 660 ppb of zearalenone can result in poor consumption, depressed milk production, diarrhea and increased reproductive tract infections (Coppock *et al.,* 1990).

Ochratoxin

Ochratoxin A is nephrotoxic mycotoxin formed by Aspergillus and Penicillum species. It causes polyuria, depression, decreased weight gain, low specific gravity of urine and dehydration but it is rapidly degraded in the rumen and thus thought to be of little consequence for ruminants.

Fumonosins

Fumonisin B_1 is the most prevalent member of a family of toxins produced by *Fusarium verticillioides* as well as by *Fusarium proliferratum.* Fumonosin B1 is the most prevalent in nature and occurs in maize and maize based products (Gelderblom *et al.,* 1988). It is carcinogenic and causes liver damage, lower milk production and reduced feed consumption in dairy cattle. Dairy cattle may be more sensitive to fumonosins than beef cattle due to greater production stress (Scott *et al*., 1994).

Conclusions

Mycotoxin contamination of crop and the ensuing consumption of contaminated feed ingredients by animals is an inevitable part of animal production system. Mycotoxins produce wide range of injurious effects in animals in addition to food borne hazards to humans. Ruminants diet generally includes both forages and concentrate (Azam *et al*., 2009) and may have an increased probability of multiple mycotoxin contamination. There is need to adopt effective strategies for mycotoxin decontam- ination and mycotoxin detoxification. The formulation and implementation of mycotoxins regulatory limits, regular analysis of animal feed and feed ingredients and employment of proper mycotoxin decontamination and deactivation strategy will help to reduce the economic losses to a great extent.

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