MANUSCRIPT Scientific Services...
www.manuscriptscientific.com

Journal of Infectious Diseases and Epidemiology Research

Original Research Article

A Review on Management Considerations against Mycotoxins in Dairy Cattle Ration

Osman Abdelhameed[1*] and Besher Abed Rabbo[2]

[*1]*Central Veterinary Laboratory, Khartoum, Sudan*

[2]*Jordan University of science and Technology, Jordan.*

Corresponding author: Osman Abdelhameed, Department of Virology, Central Veterinary Laboratory, Sudan, Tel: 00966500727688; E-mail: osmanhs@yahoo.com, Senior Consultant of Veterinary Services at Artat Enterprise, Saudi Arabia

Abstract

Mycotoxins, their toxicity levels and effects on animals are of greatest concern in dairy feed. In this review we discuss the mechanism of mycotoxins toxicity, the methods for testing their presence in dairy feed as well as their impact on the body antioxidant system. Many preventive strategies are applied to reduce the problem of mycotoxin in dairy feed. We reviewed the types of toxin binders available in the market with their active ingredient components and mode of action. We also propose the criteria for buying and selection the suitable and proper mycotoxin.

INTRODUCTION

Molds are living microorganisms that contaminate raw material from field to storage all over the world. Growth and type of mold depends on environmental condition (temperature, hygrometry, activity of water AW). Molds are sensitive to temperature, chemical treatments (acids are mold inhibitors) Mold are not all toxinogens and some molds can synthesize many types of toxins. These toxins are highly toxic to animals and human. Mycotoxins are small chemical molecule (secondary metabolites) produced by molds. Mycotoxin synthesis depends on environmental conditions (agriculture techniques, climate, harvest conditions & storage conditions). Mycotoxins are heat resistant, not sensitive to processing or chemical treatment (except aflatoxins). No visible signs of contamination of the raw material or feed are seen. Potentially 300,000 mycotoxin molecules were available around the world. 300 of them were identified, but only 30 were studied. Mold development consequences are mycotoxins and they exert their effects through several means:

1. Reduced nutrient absorption and impaired metabolism.
2. Color, smell, taste of the feed is modified.
3. Altered endocrine and exocrine system.
4. Suppressed immune function.
5. Cellular death.
6. Altered rumen microbial growth.

The mycotoxins of greatest concern in dairy industry are **(Table 1)**:

1. Aflatoxins.
2. Trichothecenes (T-2, DON).
3. Zearalenone (ZON).

MAIN STEP OF MYCOTOXINS TOXICITY MECHANISM IN ANIMALS

1. Absorption of toxins via intestinal barrier.
2. Metabolization in the liver leads to impair of detoxification function of the liver.
3. Release of toxin free radicals.
4. Toxicity.
5. Suppression of immune system.
6. Reduction resistance of animal to infectious agent, reduction of vaccine efficacy, reduction of therapeutically efficiency.

MYCOTOXIN TESTING

Generally, laboratories provide analysis for only a limited number of mycotoxins, perhaps including aflatoxin, ochratoxin, DON, fumonisin and T- 2 toxin. Minimum detection levels may be limiting because they are often directed at finding high levels that cause serious animal

Received: *February 28, 2021;* ***Revised:*** *March 27, 2021;* ***Accepted:*** *March 30, 2021*

Citation: Abdelhameed O & Rabbo BA. (2022) A Review on Management Considerations against Mycotoxins in Dairy Cattle Ration. J Infect Dis Epidemiol Res, 1(1): 1-6.

disease rather than low levels that are associated with production losses, impaired immunity and significant economic losses. Different methods are now used for testing of mycotoxins. These methods include the following:

- HPLC (High performance liquid chromatography).
- Mycotoxin Reference materials.
- Elisa (Enzyme-linked immunosorbent assay).
- LED (lateral flow test strips).

Table 1. Types of mycotoxins existing in dairy feed, toxicity level and effects on animals.

Mycotoxins Type	Mold (Fungi) Strains	Type of Toxin Produced by Mold (Fungi) strains	Mycotoxins Occurrence	Mycotoxin Toxicity	Effect of Mycotoxins in animals
Aflatoxins	*Aspergillus falvus, A. parasiticus, A. nomius, A. niger*	B1, excreted in milk in the form of M1. B2, G1, G2, M2	Cereals, cereals by products, oil seed meals (cotton seed), Silage, forages, milk and milk derivatives.	›20 ppb	Low feed intake, diarrhea, cute mastitis, lowering of milk production, respiratory problem, hair loss, liver damage, rumen dysfunction
Zeralenone	*Fusarium roseum, F. culmorum, F. gramminerum*	Zearalenol (ZEN)	Cereals, hay, silages.	› 500 ppb	Has estrogenic effects, decreased fertility, prolonged estrus, swelling of the vulvas, lack of appetite, poor milk production
Trichothecenons	*Fusarium tricinctum, F. roseum, F.graminearum*	T-2, Diacetoxyscirpenol (DAS), Deoxynivalenol (DON or Vomitoxin)	Pre-harvested maize and feed containing maize, wheat, and barley, cereals in wet and cool climates.	› 500 ppb for DON › 200 ppb for T-2	Gastroenteritis, diarrhea, vomiting, anemia, skin irritation feed refusal

Throughout history, mycotoxins (as we know them now) have impaired the quality of agricultural products. Major commodities such as corn, wheat, rice, soy and peanuts can be contaminated with mycotoxins, depending on growth conditions and storage conditions.

Increased concern for food and feed safety have brought mycotoxins to the spotlight and with that, the need for reliable and efficient mycotoxin screening. With over 35 years of experience in this field, Romer Labs (Austria) offers the most comprehensive portfolio of mycotoxin test kits for the detection of regulated mycotoxins (aflatoxin, ochratoxin, fumonisin, deoxynivalenol, zearalenone, t-2 and ht-2) in agricultural commodities such as raw grains and nuts, grain by-products and feed formulation.

Charm (USA) manufactures a variety of Rosa (Rapid One step Assay) tests to detect mycotoxin utilizing innovative Rosa technology. Charm lateral flow mycotoxin tests are easy to use and provide rapid quantitative results.

Neogene (USA) provides the most comprehensive range of solution and services for food process, animal protein and agriculture industries (Elisa tests and lateral flow).

R-BioPharma (Germany) also offers a wide range of analytical methods for mycotoxin analysis such as Elisa, RIDA & Smart APP.

Preventive strategies and Management of Mycotoxins

Good management practices will help reduce the problem of mycotoxins in dairy rations. The study of the toxicity mechanism in the animal will elaborated the best formulation able to fight against mycotoxins.

Consumption of mycotoxin contaminated feed led to the induction of teratogenic, cancerogenic, estrogenic, neurotoxic, and immunosuppressive effect in human / or animal. To control mycotoxin induced damages, different strategies have been developed to reduce the growth of mycotoxigenic fungi as well as to decontaminate and/or detoxify mycotoxin contaminated animal feed. Critical points, target for these strategies **is** prevention of mycotoxin contamination, detoxification of mycotoxins already present

in the feed, inhibition of mycotoxin absorption in the gastrointestinal tract, reduce induced damages when absorption occurs.

Prevention of contamination

Pre-harvest control has involved using agronomic practices which minimize mycotoxin accumulation in the field. These include proper irrigation, pesticides application and proper fertilization. Post-harvest approach for management of mycotoxins includes mycotoxin analysis of feed stuffs and diversion of contaminated lots; ammonization of corn and cotton seeds destroy aflatoxin.

The first preventive measure is to purchase ingredients that are relatively free of mycotoxins. Beware of feedstuffs that appear suspicious. Store grains at moisture levels less than 14 percent. Commence a clean-up program around the feed mill or feed troughs to eliminate damp areas suitable to mold growth. Be very cautious in the purchasing of corn and/or peanut meal during seasons when crops are being harvested following a drought.

Detoxification of contaminated feed: Decontamination processes, as indicated by FAO, needs the following requisites to reduce toxic and economic impact of mycotoxins, it must destroy, inactivate, or remove mycotoxins; it must not produce or leave toxic and/ or carcinogenic/ mutagenic residues in the final feed, it must be capable of destroying fungal spores. It should not adversely affect physical and sensory properties of the feed stuffs; it has to be technically and economically feasible. A wide range of chemicals have been shown to reduce, destroy, or inactivate mycotoxins. These chemicals include acids (hydrochloric acid), bases (ammonia, sodium hydroxide), oxidizing agents (hydrogen peroxide, ozone), reducing agents (sodium bisulfate), chlorinating agents (sodium hypochlorite, chlorine dioxide and gaseous chlorine) and miscellaneous reagents as formaldehyde.

Inhibition of gastrointestinal tract absorption: One approach is by using individual or combinations of organic acids (propionic, sorbic, benzoic and acetic acids, formic acid). Salts of organic acids for example calcium propionate and potassium sorbate are also used.

Second approach is by the addition of the mineral clay products such as phyllosilicates, bentonites and hydrated sodium calcium aluminosilicate (HSCAS) has been used to reduce the bioavailability of mycotoxin in feed. These compounds probably work by nonspecific binding to the mycotoxin and reducing the passage time through the gut barrier.

Recently, some complex indigestible carbohydrates (cellulose, polysaccharides in cell wall of yeast and bacteria) such as, glucomannans, mannooligosaccharides (Mos), peptidoglycan (Beta glucan), Esterified glucomannan and synthetic polymers such as cholestyramine & polyvinylpyrrolidone have been used as effective mycotoxin adsorbents (binders).

There are several toxin binders' products available in the market. They are varying in active ingredients and in their mode of action against mycotoxins through reduction of damage when absorption occurs.

In addition to special care to prevent the growth of moulds, detoxification measures, reduction of gastrointestinal absorption, there is a need for prevention of mycotoxin - induced toxic effects on the toxin are ingested.

Nutritional approaches, such as supplementation of nutrients, food components, or additives with protective effects against mycotoxin toxicity are assuming increasing interest since some mycotoxin some mycotoxins (FB1, AFB1, DON, and T-2) have been known to produce damages by increasing oxidative stress. Selenium, Vitamin E, Vitamin A, Vitamin C and BHT (powerful chemical antioxidant) were found to improve antioxidant status of the animal. They also protect against toxic effects of mycotoxins.

Impact of Mycotoxins on the body's antioxidant defence:

1. Increase lipid peroxidation by enhancing free radical production.
2. Damage of antioxidant system due to the decrease of natural antioxidant.

Protective effect against lipid peroxidation caused by mycotoxins was attributed to various antioxidant compounds such as vitamin A, vitamin E, vitamin C and selenium.

Mycotoxin adsorbents (binders) can substantially improve the status of antioxidant system. This effect depends on mycotoxin - binding activity of the adsorbent (binder) whether it contains antioxidant compound or not **(Table 2)**.

CHOOSING A MYCOTOXIN BINDER

To choose or buy a toxin binder one should look to the following points:

- Its capability to bind wide range of mycotoxins
- Its ability to act at each step of toxicity metabolism.
- Stimulate detoxication reaction in the liver.
- Reduce oxidative stress and improve the status of antioxidant system.
- Stimulate immunity.

Table 2. Comparison between some Toxin Binders Available in Market.

Product Name	Manufacture & Distributor	Active Ingredients	Inclusion Rate	Mode of Action	Comments
T5X -SD	Neovia, France.	Phyllosilicates, Yeast cell wall (Beta-glucan), Betaine, Vit.E, Selenium, BHT	15-30 gm/h/d in TMR	1. Reduce mycotoxin absorption (bind toxin) 2. Stimulate detoxication reaction in liver 3. Reduce oxidative stress stimulation of immunity	T5X contains various efficient natural antioxidants (Vit.E, Selenium). It contains BHT, power chemical antioxidant. It also contains Betain, which enhance liver function. It contains 1/3-1/6 Beta-glucan which support the immunity Has broad spectrum action over a range of mycotoxin
Mycofix Plus 3. E	Biomen Gmbh, Austria.	Diatomaceous Earth, Bentonite, plant Extract, Yeast cell wall, and Biomin BBSH797	Preventive dose 0.5 - 1.0 Kg/Mt of finished feed	1. Binding of toxin. 2. Mycotoxin Detoxification Stimulate of immunity.	Have natural antioxidant Plant Extract. Has no chemical antioxidant BHT, and support immunity
Nutritox	Agrarian, USA	1/ Nutritox plain: Hydrated sodium calcium Alumino Silicate (HSCAS) 2/ Nutritox special: combination of HSCAS (20%) with aflatoxin binder (80%PVPP)	1/1-2 Kg/ton/feed 2/ 150-200 gm/Ton/ feed	1. Binding of toxin 2. Broad spectrum effect (stimulate detoxication in liver) Stimulate Immunity.	No natural or chemical antioxidant agents. support the immunity.
Novasil Plus	Trouw Nutrition, USA	Hydrated Sodium Calcium Alminos Silicate (HSCAS)	10-20 gm/h/d	Mycotoxin binder and anticaking	No antioxidant substance Does not support the immunity.
Myco-Ad	Special Nutrients Inc, USA	Hydrated Sodium Calcium Alminos Silicate (HSCAS)	2.5 Kg/Mt	Binding of toxins	No antioxidant substance Does not support the immunity.
Curitox Plus	Intewe, USA	Bentonites plus Propionic acid	According to animal species	Binding of toxins	No antioxidant substance Does not support the immunity.
Toxy- nil Dry	Nutri-Ad, Belgium	Hydrated Sodium Calcium Alminos Silicate (HSCAS), Yeast Extract	Prevention: 0.5 - 1 Kg/ Mt Curative: 2-3 Kg/T	1. Binding of toxins Stimulate immunity	No antioxidant substance support the immunity.
Alfabond Alfabond Biotech	Montajat, Saudi Montajat, Saudi	1. Hydrated sodium calcium aluminosilicate (HSCAS)plus 5 free organic acids 2. Hydrated sodium calcium aluminosilicate (HSCAS)plus 5 free organic acids, plus Modified cell wall manna oligosaccharides (MOS)	1. 0.5 -2 Kg/T based on moisture & toxin 0.5 - 1 Kg/T	1. Binding toxins and anti-caking 1. Broad spectrum against various mycotoxins.	1. No antioxidant substance Does not support the immunity. 2. No antioxidant substance. Support the immunity.
ALFatrol	Kanzy Medipharm, Canada	S. Cerevisiae, Bacillus Subtils, Lactic acid bacteria, Bacillus Subtilis Extract Apergillus Oryzea, A. Niger. B- Complex vitamins 1. Oligosaccharides MOS	Application for dairy is not mentioned in their product profile. 1. In their web site the product is described as Vitamin B supplements	i. Binding toxin	No antioxidant substance Support immunity 1. Contains MOS, which has the capability of binding toxin
MTB-100 (Mycosorb)	Alltech, S.Africa.	Glucomannan, HSCAS	100gm/h/d for the first 7days, then reduce to 50gm/h/d	1. Toxin binding. i. Support immunity	Rich in Glucans, Has broad spectrum action against a range of mycotoxin

There are a number of the products on the market that claim to reduce the levels of mycotoxins in animal feeds. These are:

1. Individual or combination of organic acids (propionic, sorbic, benzoic, formic and acetic acids). Salts of organic acids for example calcium propionate, potassium sorbate are also used.
2. Inorganic Minerals Binders (Silicate binders): These include:

a. Bentonite, originally it is a clay material. Clay is silica sheet but containing high content of water. Bentonite containing primarily montmorillonite as the main constituent. Montrillonite is hydrated sodium calcium magnesium silicate hydroxide.

b. Phyllosilicate (HSCAS), HSCAS, is hydrated sodium calcium aluminosilicate.

c. Tectosilicates (Zeolite).

3. These inorganic mineral clays are thought to act by ion exchange interaction between free radicals on the clay and potentially charged groups on the toxin. This is one reason that clay binders are most effective against polar toxins such as aflatoxins [8].
4. Another system available commercially combines the crossed linked polymer, polyvinylpolypyrrolidone (PVVP) on a mineral base with epoxidase and esterase enzyme. The supplier of this product claims efficacy against a number of toxins and cites as its mode of action binding and enzyme deactivation of mycotoxins
5. One of the most recent and well -researched approaches to reducing the impact of mycotoxin contamination of fed is the dietary inclusion of products containing Beta – glucans and esterified glucomannans derived from yeast cell wall [2].

SUMMARY

1. Inorganic mineral Clay's products (Bentonite, Zeolite,), (Curitox plus from Feedco), only bind a narrow spectrum of toxins. They offer little or no protection against toxins such as Zearalenone or the Trichothecenes because these do not have functional polar group [2,3]. Further, it is necessary to add them to the diet at relatively high inclusion rates, generally more than 1% of the diet, which means that they take up valuable space in the nutrient diets.
2. HSCAS products, hydrated sodium calcium aluminosilicate, (Nutitox plain from Nafa, Novasil plus from Saudi Mix, Mycoadd from AL Washim, Toy-nil Dry from Shahroor, Alfabond from Montajat) are characterized as aflatoxin –selective clay, they are not good adsorbent for other mycotoxins [7]. It is therefore not expected to protect against feed containing multiple mycotoxins [4,5,6,9].
3. Polyvinylpolypyrrolidone (PVPP), (Nutritox Special from Nafa), has produced histochemical evidence of efficacy of PVPP against the immune depressive effect of aflatoxin [1]. The supplier of this product claims efficacy against a number of toxins and cites as its mode of action binding and enzyme deactivation of mycotoxins.
4. Yeast cell wall derived products (Glucomannan or Mono oligosaccharides and Bet-glucans), (Mycofix, from Bashih sons' company, T5X, from Artat, Alfa bond Biotech, from Muntajat, Saudi and MTB 100, From Alltech), were proved to have significant binding activity for a large number of mycotoxins [3]. It was found that yeast cell wall derived products will enhance immune function [2].

CONCLUSION

Although a number of adsorbents (binders) are available to reduce the negative effects of mycotoxin contamination of animal feed, it is likely the highest success rates will be achieved by good mill hygiene and management combined with an effective toxin binder.

The evidence currently indicates that products containing yeast cell wall derived products (Glucomannan or MOS, Beta-Glucan) fulfil the necessary criteria for a safe and cost-effective solution to mycotoxin contamination.

It is most likely also that a combination of mycotoxin binders with natural oxidant such as organic selenium and vitamin E will be an effective approach to compact mycotoxicosis in future.

REFERENCES

1. Celik I, Oguz H, Demet O, Donmez HH, Boydak M, et al. (2000) Efficacy of polyvinylpolypyrrolidone in reducing the immunotoxicity of aflatoxin in growing broilers. Br Poult Sci 41: 430-439.
2. Devegowda G, Aravind BIR, Morton MG, Rajendra K (1995) A biotechnological approach to counteract aflatoxicosis in broiler chickens and ducklings by the use of Saccharomyces cerevisiae. In: Proc. Feed Ingredients Asia '95, Singapore. pp. 161-171.
3. Devegowda G, Arvind BIR, Morton MG (1996) Saccharomyces cerevisiae and mannanoligosaccharide to counteract aflatoxicosis in broilers. In: Proc. Aust. Poult. Sci. Symp, Sydney, Australia. 8: 103-106.
4. Dwyer MR, Kubena LF, Harvey RB, Mayura K, Sarr AB, et al. (1997) Effects of inorganic adsorbents and cyclopiazonic acid in broiler chickens. Poult Sci 76: 1141-1149.
5. Garcia (2003) Avian Diseases 47: 236-240.

6. Huff WE, Kubena LF, Harvey RB, Phillips TD (1992) Efficacy of hydrated sodium calcium aluminosilicate to reduce the individual and combined toxicity of aflatoxin and ochratoxin A. Poult Sci 71: 64-69.

7. Phillips TD (1999) Dietary clay in the chemoprevention of aflatoxin-induced disease. Toxicol Sci 52: 118-126.

8. Santurio JM, Mallmann CA, Rosa AP, Appel G, Heer A, et al. (1999) Effect of sodium bentonite on the performance and blood variables of broiler chickens in intoxicated with aflatoxin. Br Poult Sci 40: 115-119.

9. Watts CM, Chen YC, Ledoux DR, Broomhead JN, Bermudez AJ, et al. (2003) Effects of multiple mycotoxins and a hydrated sodium calcium aluminosilicate in poultry. Int J Poult Sci 21: 372-378.