Understanding the effects of mycotoxins in turkeys: Part 1

Many species of fungi produce secondary metabolites called mycotoxins, several of which are highly toxic to humans and animals. Mycotoxin-producing fungi damage crops either in the field or during storage causing economic loss due to spoilage.

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Toxin production requires the presence of a mould, a suitable substrate and a suitable environment. If a mould is present, toxin production is influenced by moisture (water activity), temperature, oxygen and the nature of the substrate.

Most plant feedstuffs will provide a suitable substrate. Moulds do not just produce mycotoxins but also reduce the nutrient value of feed (see Table 1).

Types of mycotoxins

There are more than 400 known mycotoxins.

The mycotoxins of most importance to poultry are mainly produced by fungi of the genera Aspergillus, Fusarium and Penicillium and are produced either pre-harvest, during harvest or in storage or during feed processing whenever conditions are favourable.

Stress factors such as drought, poor fertilisation, high crop densities, weed competition, insect or mechanical damage at harvest, and storage conditions can affect the plant or grain's natural defences and help to promote the development of the fungal infection and lead to mycotoxin production.

Different species show varying susceptibility to mycotoxins. Poultry are highly susceptible to T-2 toxins and moderately sensitive to aflatoxins and ochratoxins. However within poultry species turkeys are more susceptible to aflatoxins than broilers but in most cases the younger the birds the more susceptible they are.

Some fungal strains are capable of producing more than one mycotoxin and also a single mycotoxin is produced by more than one fungus. The most important mycotoxins for poultry and the fungi that produce them are shown in Table 2.

Major mycotoxin producing fungi	Major mycotoxins produced	Important effects in poultry	Feed raw material affected
A. flavus, A. parasiticus	Aflatoxins – B1, B2, G1, G2	Fatty liver, decreased bodyweight gain and impaired feed utilisation, Immunosuppression	Wheat, maize, barley, sorghum, soya
A. ochraceus, P. verrucosum, P. viridicatum, P. citrium	Ochratoxins – A Citrinin	Renal dysfunction, Blood and meat spots in eggs, Decreased bodyweight gain and impaired feed utilisation Immunosuppression	Barley, oats, wheat, rye
F. verticilloides	Type A Trichothecenes:	Tongue lesions	Barley, oats, wheat, rye
F. moniliforme	T-2 toxin, HT-2 toxin, diacetoxyscirpenol	Oral/dermal toxicity	Barley, oats, sorghum, soya, maize, wheat
F. graminearium	Type B Trichothecenes:	Gizzard lesions	Wheat and barley
F. pseudograminearium	Nivalenol, Deoxynivalenol, Fusarenon-X	Decreased bodyweight gain and impaired feed utilisation	Wheat and barley
F. culmorum	Fumonisins	Immunosuppression	Wheat and barley
F. poae	Zearalenone		Wheat and barley

Table 2. Major mycotoxins (Aviagen Turkeys, 2008).

Aflatoxins

Aflatoxins are the most widespread and most studied group of all mycotoxins.

The toxin occurs in warm and humid climatic conditions and is not considered a problem in colder climates however the global availability of feed stuffs means contaminated materials can occur anywhere in the world.

Aflatoxin B1 is the most common and biologically active of all the aflatoxins and causes decreased growth, egg production and mortality. Clinically the signs are anorexia, visceral haemorrhages embryo toxicity and increased susceptibility to stressors.

Histopathology of turkeys reveals fatty liver, liver necrosis and bile duct hyperplasia.

Aflatoxin B1 also suppresses the immune system and reduces vaccine response.

Aflatoxins decrease the activities of several digestive enzymes resulting in reduced feed conversion

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Table 1. Mould growth decreases the nutritional value of corn.

Parameter	Good corn	Mouldy corn	Reduction (%)
Total fat (%)	3.8	2.4	36.8
Fatty acid content Palmitic (16:0)	11.3	9.1	19.5
Metabolisable energy (kcals/kg)	3,350	2,510	25.1
Carotene (mg/kg)	3.1	2.3	25.8

Table 3. The effect of aflatoxin B1 (AFB1) only or co-administered with a feed additive (Mycotox NG) on haemagglutination titres against Newcastle disease in turkeys.

Treatment	Antibody titres (log210)	
	21 days of age	42 days of age
Control	7.10±0.031	8.1±0.23
Feed additive (0.5g/kg)	7.28±0.038	8.0±0.39
AFB1 (0.2mg/kg)	$4.30\pm0.44^{1c,2c}$	$5.9\pm0.34^{1c,2c}$
AFB1 (0.4mg/kg)	$4.10\pm0.34^{1c,2c}$	$5.0\pm0.36^{1c,2b}$
AFB1 + feed additive (0.2mg/kg)	$6.00\pm0.51^{2a,4a}$	$6.6\pm0.34^{2b,4a}$
AFB1 + x feed additive (0.4mg/kg)	$5.10\pm0.60^{1a,2b,3a}$	$6.0\pm0.44^{1b,2b,4a}$

Aflatoxin (mg/kg feed)	Effect on egg production
2.5	Egg production reduced
10.0	50% reduction
20.0	100% reduction

Table 4. The effect of aflatoxin level on layer bird performance.

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efficiency. Aflatoxins are known to interfere with vitamin D metabolism contributing to reduced bone strength and leg weakness.

Suppression of hepatic protein synthesis is the main factor resulting in growth suppression and reduced egg production. Aflatoxins are also associated with poor fertility and hatchability.

Perhaps the most important effect of aflatoxins is the immune suppressing effect and consequent vaccine and therapeutic drug failures. Immunosuppression can also occur at levels of mycotoxins that are undetectable by routine screening methods.

Table 3 shows the effect of two levels of Aflatoxin B1 (with and without a toxin binder) on haemagglutination titres against Newcastle disease in young turkeys.

Aflatoxicosis has also been shown to increase the susceptibility to salmonellae infection.

The effects of aflatoxins on bird performance are dose dependent (see Table 4).

Trichothecenes

Type A trichothecenes (T-2 toxin, HT-2 toxin, diacetoxyscripenol) are a major concern. They impact bird health and welfare, and cause economic losses in productivity. They can be found in cereals and cereal by-products and feeds.

They cause oral lesions dermatitis (see Fig. 1) and intestinal irritation.

T-2 toxins reduce feed intake, they are often referred to as 'the feed refusal' toxins, reduce body weight, egg production, egg shell quality and regression of ovaries in laying birds. The effect of T-2 toxin on laying hen performance has been demonstrated at different dosage levels (see Table 5).

T-2 toxins have also been known to cause gizzard erosions and necrosis of the proventricular mucosa. They are the second most immune suppressive mycotoxins after aflatoxins, occurrence of both toxins is the most immunosuppressive combination of toxins.

Ochratoxins

Ochratoxin type A (OTA) is a common contaminant in a variety of feedstuffs, OTA is produced mainly by aspergillus species. It is a nephrotoxin significantly depressing feed intake, growth, feathering, egg production and feed conversion efficiency.

OTA has been found to be teratogenic in several species, craniofacial abnormalities of the offspring being the most common signs. Anecdotal evidence suggests that OTA can result in significant embryonic loss and malformations in the field (see Fig. 2).

Egg shell quality can be affected along with yellow staining of egg shells and blood spots. OTA is three times more toxic to young birds than aflatoxins.

Severely affected birds show urate deposits in joints and in the abdominal cavity. Acute OTA toxicity results in acute renal failure leading to death.

Fig. 1. T-2 toxin oral lesions and necrosis. Top, normal tongue and palate. Bottom, affected tongue and palate with lesions (Kimron Veterinary Institute).

Fig. 2. Malformation of turkey embryos associated with ochratoxin type A (image courtesy of M. Behl, Select Genetics).

Zearalenone (ZEA) and Deoxynivalenol (DON)

Zearalenone is responsible for reproductive disorders due to its oestrogenic effect at high concentrations. Poultry are quite resistant to zearalenone, however at high concentrations vent enlargement and enhanced secondary sex characteristics are seen. Layers are considered resistant to zearalenone even when fed at up to 800mg/kg. However zearalenone will contaminate eggs which is a concern in terms of reproductive performance. Chicks derived from hens fed zearalenone contaminated feed contained ZEAs.

Poultry are quite resistant to DON however there is an association with reduced feed intake in layers and breeders, the toxin is sometimes considered an indicator that other more potent fusarium are present.

Fumonisins

Fumonisins are found in tropical and temperate climates. Performance related effects include reduced weight gain and poor FCR. Clinical signs are spiking mortality, which, includes paralysis, extended legs and neck, poor gait, gasping, increased liver weight and liver necrosis.

Co-contamination of feeds by mycotoxins

Co-contamination of mycotoxins appears to exert greater negative impact on health and productivity than do single toxins, for example both aflatoxin and ochratoxin are extremely toxic to poultry and they act synergistically.

The toxicity resulting from dual exposure to aflatoxin and ochratoxin is much greater than the sum of their individual toxicities. The effects of T-2 and DAS were additive in laying hens for feed intake, oral lesions, mild changes in plasma enzyme activities and reduced egg production. Fungi do not occur in feedstuffs as pure cultures so the number of possible combinations of toxins is very significant.

The key point is that a feedstuff testing positive for a particular toxin signifies that growing conditions were favourable not just for that fungi but also for others. Therefore testing the feedstuff for other co-contaminants is important. ■

Part 2 will be published in the next issue of International Hatchery Practice.

Table 5. The effect of T-2 toxin on laying hen performance.

T-2 toxin (ppm)	Egg production (%)	Egg weight (g)	Body weight (g)
0.0	96.29	52.45	1,332
0.5	93.81	51.77	1,313
1.0	91.75	51.35	1,286
2.0	86.65	51.33	1,285