The impact of mycotoxins on reproduction of breeding chickens

by Dr Swamy Haladi, global technical manager, Alltech.

Mycotoxins are secondary metabolites of moulds, which are ubiquitous in nature. Four major genera of mycotoxin producing moulds on a global scale include Aspergillus, Fusarium, Penicillium and Claviceps. Recent mycotoxin survey work on Alternaria toxins from Argentina, is also forcing us to include Alternaria mould into the above list.

Depending on various factors, one or more of these moulds grow on crops while they are in the field as well as during storage.

There are more than 500 mycotoxins that have been identified to date, and undoubtedly there are many more to come. The immediate challenge facing chemists around the world relates to masked mycotoxins and the means and modes of analysing them so that their masked effects can be quantified.

The objective of this short article is to highlight the demonstrated effects of the key mycotoxins on poultry reproduction. These include aflatoxins, ochratoxins, Type A trichothecene Fusarium mycotoxins, Type B trichothecene Fusarium mycotoxins, zearalenone, fumonisins, moniliformin and ergot alkaloids. Alltech's 37+ Program, wherein more than 37 mycotoxins can be analysed using state of the art UPLC-MS/MS, has indicated the role of several other mycotoxins in addition to those listed above.

Let us take an example of Type A trichothecene mycotoxins. These are produced by certain Fusarium moulds and include several mycotoxins including T-2 toxin, HT-2 toxin, diacetoxyscirpenol (DAS) and neosolaniol. Commercially, feed samples are tested only for T-2 toxin.

Alltech's 37+ Program has shown that even when T-2 toxin was not detected in feeds, neosolaniol was found which may cause toxicity.

Mycotoxin	LD50 (mg/kg BW)
Ochratoxin	2.14
DAS	3.82
T-2 toxin	5.00
Moniliformin	5.4
Aflatoxin B1	6.5
HT-2 toxin	7.22
Neosolaniol	24.87
DON	140

Table 2. LD50 values for some of the mycotoxins in poultry (Leeson et al., 1995).

Classifying the mycotoxins to a specific region has been curtailed in recent years due to the extended trading of grains and meals across the world, as well as appreciable changes in the global climatic conditions. Unexpected drought, rainfall and floods added more mystery to the already complex issues of sam pling and mycotoxin analysis.

Nevertheless, the greater prevalence of a specific group of mycotoxins to a particular region can be generalised (Table 1).

Based on LD50 values (amount of mycotoxin required to kill 50% of test population), the order of severity for some of the mycotoxins is as follows: ochratoxins, diacetoxyscirpenol (DAS), T-2 toxin, moniliformin, aflatoxins, HT-2 toxin, neosolaniol, seoxynivalenol (DON) (Table 2).

Although aflatoxins are very well studied in poultry, ochratoxins, DAS and T-2 toxin are more toxic than aflatoxins. However, such relative toxicity information specific to reproduction is not available at the moment.

Table 1. Global distribution of mycotoxins (Placinta et al, 1999; Azcarate et al, 2008, Diseases of Swine, Ninth Edition, 2006 (Straw, Zimmerman, D'Allaire, and Taylor).

Moulds	Key mycotoxins	Region
Alternaria spp in wheat	Alternariol, Alternariol methyl ether, Itertoxin-I, Altenuene	Argentina
Aspergillus flavus, Aspergillus parasiticus	Aflatoxins, Cyclopiazonic acid	Asia, Latin America, Africa, Southern USA
Aspergillus ochraceus	Ochratoxins, Citrinin	Asia, Latin America, Southern USA, Africa
Claviceps purpurea in cereal grains and grasses	Ergot alkaloids	Africa, Asia, Australia, Europe, the Americas
Claviceps africana in sorghum	Ergot alkaloids	Southern Asia, Africa, Australia, the Americas
Fusarium sporotrichoides, Fusarium poae	T-2 toxin, HT-2 toxin, Diacetoxyscirpenol	Brazil, Canada, USA, India, Russia, Siberia, Ukraine
Fusarium graminearum in wheat, barley, and oats	Deoxynivalenol, Zearalenone, Nivalenol	Canada, Northern USA, Europe, Japan
Fusarium graminearum, Fusarium culmorum in corn	Deoxynivalenol, Zearalenone, Nivalenol	Midwest USA, Canada, Europe, New Zealand, Japan, Argentina.
Fusarium moniliforme, Fusarium proliferatum	Fumonisins, moniliformin	Southern USA, Western Europe, Asia, Africa, Latin America
Penicillium viridicatum	Ochratoxins	Canada, Europe

Reproduction

Minor reductions in fertility and hatchability of breeding chickens can lead to significant losses in farm profits. The reproductive systems are generally more sensitive to mycotoxins than growth indices. Aflatoxins and some of the Fusarium mycotoxins have received considerable attention in this area (Table 3).

The feeding of 38mg/kg DON in F. graminearum-infected corn increased the percentage of non-viable germs and late embryonic deaths. Relatively less yolk and more albumen in eggs was also observed.

Yegani et al. (2006) reported increased early embryonic mortality associated with reduced eggshell thickness in broiler breeder hens fed naturally contaminated diets containing 12.6mg/kg DON and lesser amounts of other toxins.

Similar observation was noted by Bergsjø et al., 1993 albeit at DON concentrations of around 5ppm. It is interesting that body weight, feed efficiency and egg production

Continued on page 16

Continued from page 15
were not affected in breeders fed diets contaminated with Fusarium mycotoxins in spite of the various adverse effects on the reproduction parameters.

Stanley et al. (2004) fed 3ppm aflatoxins to breeder hens and observed no negative effects on fertility. However, hen-day egg production, percentage of hatchability and serum total protein concentrations were significantly lower in the birds fed aflatoxins. On the contrary, embryonic mortality increased significantly.

HACCP-like approach

The use of a HACCP-like approach to control mycotoxins is highly recommended in feed mills and farms so that factors such as moisture and water activity of grains, temperature and relative humidity of environment are controlled.

Better aeration of storage silo structures and frequent cleaning of feed mill equipment are also desirable to control mycotoxin production. This is the basis of Alltech's MIKO Program, a comprehensive and integrated approach to reduce the incidence of mycotoxicoses in poultry.

It is difficult to determine the precise economic impact of mycotoxins in breeding chickens because of the subtle and non-specific nature of the problem.

However, a controlled and peer-reviewed study from Prairie View A and M University, Texas, USA has indicated;

- 14% decrease in hen-day egg production due to mycotoxins.
- 11% decrease in hatchability due to mycotoxins.
- 9% increase in embryonic mortality due to mycotoxins.
- Feeding Mycosorb contributed to the control of mycotoxins.

To conclude, breeding chickens are susceptible to mycotoxins due to long term exposure and increased sensitivity of reproduction systems to mycotoxins. The non-specific symptoms and subtle nature of the mycotoxin challenge warrants the implementation of mycotoxin prevention steps all along the mycotoxin production chain rather than waiting for the devastation to happen.

Every breeder operation should have their own mycotoxin management programme to ensure that their team is trained on the issue, the problem is diagnosed at an early stage and necessary control steps are implemented. ■

Table 3. Effects of mycotoxins on breeder performance (Girgis and Smith, 2011; Stanley et al., 2004).

Mycotoxin source	Mycotoxin concentration (ppm)	Exposure (weeks)	Effects
Corn purposely infected with F. graminearum	DON: 38	58-63	Decreased yolk percentage
Naturally contaminated oats	DON: 2.5-4.9; 3-acety-DON: 0.25-0.63; ZEN: 0-0.55	21-28	Increased incidence of unwithdrawn yolk sac, cloacal atresia, cardiac anomalies and delayed ossification
Naturally contaminated wheat and corn	DON: 12.6; 15-acety-DON: 1; ZEN: 0.6	27-38	Transient reduction in egg production, increased early embryonic mortality, decreased eggshell thickness, decreased antibody titers to infectious bronchitis disease
Laboratory inoculated fungal culture	Aflatoxins: 3	35-37	Decreased hen-day egg production, increased embryonic mortality, lowered hatchability