MYCOTOXIN MANAGEMENT

MANAGING MYCOTOXINS IN LAYING HENS PART 1

By Dr Swamy Haladi, Alltech Global Technical Manager for the Mycotoxin Management Team

Laying hens are susceptible to mycotoxins for a couple of reasons. The longer rearing period (70 weeks or more) makes them the best candidates for chronic mycotoxicoses.

This can be further influenced by the increased use of byproducts in layer diets which can contain up to three times more mycotoxins than the grains.

Although more than 500 mycotoxins have been characterised, the most significant ones from the commercial layers perspective are aflatoxins, ochratoxins, vomitoxin (DON), T-2 toxin, zearalenone, and fumonisins.

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.

Mycotoxins are proven to affect the bottom line of layer operations through many routes. These include the effects on egg production, egg weight, egg shell thickness, leg weakness, and immunity.

The effects on egg production and egg weight can be explained by the impact of mycotoxins on feed intake, liver health and gut integrity. The effects on immune system, both antibody and cell mediated, make the birds more susceptible to infectious diseases. These changes are often subtle in nature and, therefore, go unnoticed.

The negative effects of mycotoxins on bone are primarily due to their effects on metabolic factors such as Vitamin D. Some of the mycotoxins can also affect the functioning of skeletal muscle leading to leg weakness. Leg weakness can lead to increased mortality due to starvation, dehydration and trampling as well as poor growth and egg production and increased culling.

The key effects of some of the mycotoxins on leg weakness and their mode of action can be seen in Table 1.

The optimum egg shell quality in layers is critical to control nutrient losses, reduce bacterial contamination and increase shelf life of eggs.

Shell integrity is the parameter of egg shell quality most commonly affected by mycotoxins. However, mycotoxins can also affect shape, texture and cleanliness of eggs.

The key effects of some of the mycotoxins on egg shell quality and their mode of action can be seen in Table 2.

The use of HACCP principles to control mycotoxins is highly recommended at feed mills and farms so that factors such as moisture and water activity of grains, temperature, and relative humidity of environment is controlled.

Better aeration of storage silo structures and frequent cleaning of feed mill equipment is also desirable to control mycotoxin production.

This is the basis of Alltech's MIKO programme, a comprehensive and integrated approach designed to help control mycotoxicoses in poultry.

It is hard to put a finger on the economic impact of mycotoxins in laying hens because of the subtle and non-specific nature of the problem. However, a controlled and peer reviewed study from University of Guelph, Canada has indicated:

- A 6% decrease in egg production due to mycotoxins.
- A 13% increase in feed intake due to mycotoxins.
- For a 100,000 capacity layer farm, the losses per day = $700.
- Mycosorb supplementation to the mycotoxin group contributed to the control of mycotoxins.

To conclude, laying hens are susceptible to mycotoxins due to long term exposure and an increased trend in the use of by-products in the diets.

The non-specific symptoms and subtle nature of the mycotoxin challenge warrants the implementation of mycotoxin prevention steps all along the production chain, rather than waiting for the devastation to happen.

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

Mycotoxin(s)	Mode of action
Aflatoxins/ Cyclopiazonic acid	Reduced minerals (Ca, P and Zn), vitamins (A and D) and parathyroid hormone functions, increased Ca excretion
T-2 toxin, DAS, DON	Reduced shell surface density, kidney damage, reduced Ca binding proteins
Zearalenone	Oestrogen mimicking effects, disrupts localisation of carbonic anhydrase enzyme in the shell
gland, reduced serum Ca but	increased P
contents	
Ochratoxins	Kidney damage
Citrinin and patulin	Reduced egg shell Ca content, alter egg shape
Fumonisins	Reduced shell weight

Source: Devegowda and Ravikiran, 2008

Table 2. The mode of action of mycotoxins on egg shell quality.

Table 1. Relationship between skeletal abnormalities and mycotoxins.

Skeletal abnormality	Causative mycotoxin(s)
Tibial dyschondroplasia	Fusarochromanone, T-2 toxin, DAS
Rickets	Aflatoxins, ochratoxins, T-2 toxin
Articular gout	Ochratoxins, aflatoxins, citrinin
Spiking mortality syndrome	Fumonisins
Cage layer fatigue	Aflatoxins, ochratoxins

Source: Devegowda and Ravikiran, 2009

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MANAGING MYCOTOXINS IN BREEDING CHICKENS PART 2

By Dr Swamy Haladi, Alltech Global Technical Manager for the Mycotoxin Management Team

Mycotoxicosis in breeding chickens gets greater attention from the poultry industry when compared to commercial broilers and layers. This is understandable, considering minor reductions in fertility and hatchability in breeding chickens can lead to significant losses in farm profits.

A minor increase in mortality rates of breeding chickens can reduce the potential of the farm to produce the necessary number of chicks for their operations. The immune and reproductive systems are generally more sensitive to mycotoxins than growth indices.

Although more than 500 mycotoxins have been characterised, the most significant ones from the breeding chickens' perspective are aflatoxins, ochratoxins, vomitoxin (DON), T-2 toxin, zearalenone, and fumonisins.

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.

Mycotoxins are proven to affect the bottom line of breeder operations in many ways. These include effects on egg production, egg weight, egg shell thickness, leg weakness, fertility, hatchability and immunity.

The effects on egg production and egg weight can be explained by the negative impact of mycotoxins on feed intake, liver health and gut integrity.

Effects on the immune system, both antibody and cell mediated, often make the birds more susceptible to infectious diseases. Last of all, the effect on reproduction can be attributed to the direct effects of mycotoxins such as zearalenone on reproductive organs or the result of indirect effects on immunity and feed intake.

Egg shell quality

Optimum egg shell quality in breeders is critical to control nutrient losses and reduce bacterial contamination and embryonic mortality. Shell integrity is the parameter of egg shell quality most commonly affected by mycotoxins.

However, mycotoxins can also impact shape, texture and cleanliness of eggs. Please refer to Part 1 of this Mycotoxin Solutions Series for more information on the key effects and mode of action of mycotoxins on egg shell quality.

Mycotoxins and reproduction

The feeding of 38mg/kg DON in F. graminearum-infected corn increased the percentage of non-viable germs and late embryonic deaths (Moran et al., 1987). The eggs in this study had relatively less yolk and more albumen.

Yegani et al. (2006b) reported increased early embryonic mortality, associated with reduced eggshell thickness, in eggs produced by broiler breeder hens fed naturally contaminated diets containing 12.6mg/kg DON, and lesser amounts of 15-acetyDON and ZEN.

DON at a concentration of 4.9mg/kg, combined with other Fusarium toxins in naturally contaminated oats, increased embryonic developmental anomalies and delayed ossification (Bergsjø et al., 1993).

Body weight, feed efficiency and egg production were not affected in breeders fed diets contaminated with Fusarium mycotoxins in spite of the various adverse effects in the above experiments.

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. Crucially, there was a significant increase in embryonic mortality.

Mycotoxins and immunity

Robust immunity is particularly important in breeders to protect these birds during their relatively long life and to ensure success of vaccination programs. It is also required for the transfer of maternal immunity to the progeny at a level sufficient to provide protection during the first few days post hatching.

Fusarium mycotoxins, even at concentrations that do not result in an obvious adverse effect on performance, can be subtle modulators of immunity. Broiler breeder pullets fed naturally contaminated grains did not restore the pre-challenge percentage of circulating CD8+ T cells upon recovery from coccidial infection (Girgis et al., 2008).

Decreased immune response to vaccines has also been observed in layers, broilers and other poultry species. Serum antibody titers to infectious bronchitis virus decreased in broiler breeders fed naturally contaminated diets (Yegani et al., 2006b).

Antibodies to Newcastle disease virus (NDV) decreased in layers exposed to DON (Harvey et al., 1991) or to multiple Fusarium mycotoxins (Dänicke et al., 2002).

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 is also desirable to control mycotoxin production.

This is the basis of Alltech's MIKO Program, a comprehensive and integrated approach to prevent and control 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 (Stanley et al., 2004) 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 program to ensure that their team is trained on the issue, the problem is diagnosed at an early stage and necessary control steps are implemented. ■

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MANAGING MYCOTOXINS IN BREEDING CHICKENS PART 3

By Dr Swamy Haladi, Alltech Global Technical Manager for the Mycotoxin Management Team

The commercial broiler chicken industry has seen unparalleled growth over the last decade due to the growing human population, changes in consumer preference and availability of alternative sources of animal protein.

Genetic improvements played a major role in bringing broiler chickens to the table faster and with much greater feed efficiency. This, unfortunately, came at the cost of poor defence mechanisms, leading to increased susceptibility of broilers to many metabolic and infectious conditions.

The suppression of the immune system and consequent increased mortality is not the only mechanism through which mycotoxins affect the bottom line of broiler operations.

They can also directly compromise bone strength, feed intake, weight gain, feed efficiency and meat quality.

Mycotoxins and bone strength

The effect of key mycotoxins on leg weakness and their mode of action was discussed in detail in Part One (Devegowda and Ravi Kiran, 2009).

The tremendous body weight of broiler chickens compromises bone strength and mycotoxins can exaggerate such negative effects. Broilers with poor bone strength cannot readily access feed and water, leading to death or poor weight gains.

Mycotoxins and immunity

Aflatoxins, T-2 toxin, deoxynivalenol (DON or vomitoxin), fumonisins and many other mycotoxins are known to affect either cell-mediated or antibody-mediated immunity or both. This means that we can expect higher mortality in flocks exposed to mycotoxin-contaminated feeds.

Aflatoxins have been very well studied in broiler chickens and have been shown to affect mainly cell-mediated immunity (Swamy, 2009).

This means that although these toxins don't have any direct effect on antibody production, they reduce the immune status of birds by compromising the functions of lymphocytes and macrophages.

Unlike aflatoxins, fusarium mycotoxins such as DON can directly affect antibody production and can result in lower antibody titers to infections such as Newcastle disease.

These toxins can also compromise cell-mediated immunity through decreasing the populations of CD4+ and CD8+ lymphocytes.

This has been confirmed in a recent study wherein feeding DON-contaminated feed to broiler-breeder chicks resulted in a seven day delay in the recovery from coccidiosis infection (Girgis and Smith, 2011).

Such delay can not only increase the chances of higher mortality in broiler flocks but can also affect bottom line of broiler operations through increased morbidity.

Alltech recently launched its 37+ Program wherein more than 37 mycotoxins can be analysed in a single run using state of the art UPLC-MS/MS technology.

This Program has revealed the potential role of several mycotoxins, other than the ones mentioned above, in compromising the immune system of broiler chickens.

These include diacetoxyscirpenol, neosolaniol, nivaleol, and patulin. In fact, nesolaniol was detected in a larger number of samples than T-2 toxin but commercial laboratories do not test for neosolaniol.

Mycotoxins and performance

The ultimate objective of any broiler operation is to produce quality meat as efficiently as possible.

For this to happen, it is necessary to achieve optimum intestinal health along with general health of birds.

Recent evidence supports the fact that mycotoxins affect performance parameters such as weight gain and feed efficiency mainly through compromising intestinal health.

This is particularly true for Fusarium mycotoxins.

Unlike pigs, broiler chickens continue to consume Fusarium mycotoxin-contaminated feeds and therefore their gastro-intestinal tract gets exposed to toxin assault (Swamy et al., 2004).

Mycotoxins and feed efficiency

Fusarium mycotoxins can affect feed efficiency through reducing intestinal villi height and width.

This affects both digestion of feed and absorption of nutrients. Nivalenol, one of the Fusarium mycotoxins commonly seen in European feeds, can also cause gizzard erosion which, in turn, can affect digestion of feed.

Fusarium mycotoxin-induced reduction in liver size may also affect the ability of the liver to produce bile salts and hence compromise feed digestion.

Last but not least, what about mycotoxins and broiler meat quality?

Aflatoxins and DON have been associated with reddish discolouration of meat.

Although the mechanism of action of these two mycotoxins on meat discolouration is different, the ultimate effect is carcase condemnation, meaning poor profits for broiler operations (Swamy et al., 2002).

Mycotoxin management

The formation of mycotoxins in the field is influenced by many factors, most of which are outside the control of animal producers.

The production of mycotoxins during storage of raw materials and feed, however, can be controlled to a greater extent.

A HACCP-like approach to control mycotoxins, therefore, 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 control mycotoxicoses in poultry. Several peer-reviewed studies in broiler chickens have shown that feeding Mycosorb contributed to the control of mycotoxins (Arvind et al., 2003; Kamalzadeh et al., 2009).

To conclude, mycotoxins can induce economic losses in broiler chickens. Every broiler 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. ■