

# The impact of mycotoxins on immunity and vaccination responses

by Dr Jules Taylor-Pickard, Global Mycosorb Manager, Alltech Inc, European Bioscience Centre, Sarney, Summerhill Road, Ireland.

Mycotoxins have now been identified as a major threat to animal health, welfare and performance. Until recently poultry were considered to be relatively insensitive to mycotoxicosis, however over a decade of research has shown that this is a fallacy. In fact, they have various sensitivities to fungal toxins, including mouth lesions, major liver damage and immune problems, as well as poor vaccination responses.

Poultry performance can be severely affected when exposed to any levels of fungal contaminants, whether sub-clinical or not. Poultry kept under intensive management systems are particularly at risk as they commonly show poor immune responses or immune depression due to their environment and management.

Ensuring an efficient immune response, especially to costly vaccination programmes, is important in conveying vaccination protection in birds, especially for overcoming the multiple disease challenges present within the environment in the crucial first few weeks of life.

Single moulds can produce several types of toxins and, conversely, several fungi may produce the same type of toxin. It is now known that, whatever the type and level of contamination, most contaminated feed-stuffs will contain more than one type of toxin.

These toxins in combination, even at low levels, cause a larger problem to animals than single toxins alone, and are difficult to

diagnose due to the multiplicity of symptoms an animal may show as a result of consuming contaminated feed or bedding.

Various broiler trials have shown reduced immuno-competence and poorer vaccination responses in poultry fed mycotoxin-contaminated feed.

This is thought to be due to the oxidative damage caused by mycotoxins, which in turn increase the requirements for antioxidants to prevent cellular and tissue damage in the animal.

The immune system is very sensitive to levels of oxidising free radicals, and hence the impairment in immune function when exposed to high levels of mycotoxin contamination in feed.

Important moulds and their mycotoxins are shown in Table 1. These include field

toxins (which can be present on both grain and straw, if used as bedding) as well as fungal contaminants associated with storage of materials.

Moulds require certain conditions to grow, which include a suitable substrate, moisture levels exceeding 14% RH, temperatures above 60°F, 0.5% oxygen and a pH ranging between 4 and 8, depending on fungal species.

Where growing seasons and harvests are wet and storage conditions are not ideal, fungal growth is inevitable, and contamination is impossible to avoid.

## Vaccination trials

Fusarium toxins have been reported to affect immune responses in poultry. Javed et al. (1995) studied the effect of Fusarium contamination in feed materials on 1-35 day old broilers, and reported a decrease in white blood cells and impaired titres to the Newcastle disease virus in vaccinated birds.

Trials with aflatoxin showed that growing broilers (up to 42 days old) had lower antibody titres, and a poorer responsiveness of the immune system to invading organisms or vaccination.

Swamy et al. (2002) fed naturally contaminated feed, which contained several forms of Fusarium mycotoxins, to broilers from day old for 56 days, resulting in significant reductions in antibody (IgA) levels.

As IgA forms the first line of defence in, for example, the respiratory tract, this is crucial for intensively housed poultry.

Further work examined the impact of T2 and CPA toxins on antibody titres to Newcastle disease. These toxins had an immunosuppressive impact on 1-28 day old vaccinated broilers to Newcastle disease.

Mycotoxins interfere with various immune tissues, including lymphoid organs. With aflatoxin and ochratoxin exposure, poorer protein synthesis is considered the main cause of immune suppression, and other studies have shown that mycotoxins caused a reduction in mitotic cell number in the bursa organ in broilers.

Feeding contaminated diets has also been shown to reduce the humoral immune

*Continued on page 9*

**Table 1. Main moulds and mycotoxins found in feed and bedding materials.**

| Field origin   | Storage origin     |                  |
|----------------|--------------------|------------------|
| FUSARIUM       | PENICILLIUM        | ASPERGILLUS      |
| Deoxynivalenol | Ochratoxin         | Aflatoxin        |
| Zearalenone    | PR                 | Ochratoxin       |
| T-2            | Patulin            | Sterigmatocystin |
| Fumonisin      | Penicillic acid    | Fumintremorgens  |
| Moniliformin   | Citrinin           | Fumigaclavins    |
| Nivalenol      | Penitrem           | Fumitoxins       |
| Fusaric acid   | Cyclopaizonic acid | Glilotoxin       |

Continued from page 7  
 response to Newcastle disease virus (NDV) vaccine.

In a commercial situation, this effect would reduce vaccine efficiency. In broiler breeders, a reduction in the transfer of maternal immunity in broiler chicks can cause lower liveability of hatchlings.

Fumonisin inhibits the activity of the enzyme sphinganine N-acyl transferase, showing that cellular membranes can be directly affected by toxins *in vivo*, which in turn dictates the integrity and function of immune cells.

Ledoux et al. (1992) found that fumonisin ingestion in chickens decreased humoral immunity, suppressed lymphocyte proliferation and reduced bacterial clearance.

Unpublished studies by Santin found an increasing linear interference of fumonisin on vaccine titres against NDV in broilers.

Petska et al. (2004) showed that the mycotoxin DON and other trichothecenes affected both cellular and molecular immune genetic modulation (either up- or down-regulation). Low doses of trichothecenes have been associated with immune stimulation.

Conversely, high levels of toxin ingestion increased leukocyte cell death and immune suppression.

Over or inappropriate stimulation of the immune system is not desirable, as it diverts energy and nutrients away from growth performance.

Immune suppression in commercial poultry flocks, whether growing or breeding

farms, cause reductions in vaccine titres, increases in infections (for example *E. coli* or *Clostridium* spp.) and more carcass downgrades due to lesions.

In the case where toxins over-stimulate immune responses, a strong vaccine reaction and poorer feed conversion rate may result.

Prevention of damage and poor functionality of the immune system due to toxin exposure can be addressed by using a proven, effective mycotoxin binder, such as Alltech's  $\beta$ -glucan based product (ABG).

Table 2 shows how the negative impact of two different mycotoxins, in relation to immunity, can be reversed.

**Table 2. Effects of in-feed protective agents on the antigen specific immune response in mycotoxin induced immunocompromised animals.**

| Compound                            | Mycotoxins                          | Species | Observations   |
|-------------------------------------|-------------------------------------|---------|--|
| ABG<br>Glucomannans<br>(2kg/t feed) | AFBI - 0.4, 0.9<br>or 1.9mg/kg feed | Pig     | Restore the OVA specific lymphocytes proliferation after immunisation (Meissonnier et al., 2009) |
| Glucomannans<br>(2kg/t feed)        | T2- toxin - 1.2 or<br>2.0mg/kg feed | Pig     | Restore the OVA specific IgG production after immunisation (Meissonnier et al., 2009)            |

## Maximising efficacy

Correct and efficient vaccination responses in all poultry flocks, whether growing birds, hatchlings or breeder flocks, is essential for maintaining economic production and welfare standards, as well as reducing the risk of disease spread.

To give the best protection available, producers can take several steps to give young birds the best chance of disease resistance.

This can be achieved by either ensuring the birds are not exposed to mycotoxins, which is not possible to guarantee no matter how good the quality controls are, or by using a proven mycotoxin binder. ■