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# Occurrence of Mycotoxin in poultry feed and their control measures

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***Abstract***

Mycotoxins are secondary metabolites produced by fungi that can contaminate food and cause serious health problems. Worldwide, approximately 25% of food crops are affected by mycotoxins. Mycotoxin causes economic losses, diseases, and even the death of humans and animals. Aflatoxin affects all poultry species. Young poultry, especially ducks and turkeys, are very susceptible to aflatoxicoses. As a general rule, the maximal allowed for growing poultry is a 20 µg/kg diet. Mycotoxins can cause hatch defects, such as lower hatchability. Mycotoxins can also cause reduced growth, reduced egg production, poor feed efficiency, increased liver fat, changes in organ weights, reduced serum protein levels, carcass bruising, poor pigmentation, and loss of appetite. Different types of toxin binders in poultry feed can be used for reduce the effect of mycotoxin.

## Introduction

Worldwide, approximately 25% of food crops are affected by mycotoxins causing a loss of nearly 1 billion tons of foodstuff per year (Bryden, 2007, Channaiah, 2011). The term "mycotoxin" is derived from "mykes" meaning fungi and "toxicon" meaning poison. Mycotoxins are secondary metabolites produced by fungi that can contaminate food and cause serious health problems. There are over 200 species of molds that produce mycotoxins. Aflatoxins (**AF**), zearalenone (**ZEN**), ochratoxin A (**OTA**), fumonisins (**FUM**), trichothecenes such as deoxynivalenol (**DON**), and T-2 toxin are some of the mycotoxins that can significantly impact the health and productivity of poultry species More than 400 mycotoxins have been reported in food and feed. The most frequently detected, and of concern globally, are aflatoxin B1 (AFB1), aflatoxin B2 (AFB2), aflatoxin G1 (AFG1), and aflatoxin G2 (AFG2); fumonisins (FBs);



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trichothecenes (for example, deoxynivalenol (DON) and T-2 toxin (T-2)); and ochratoxin A (OTA) (Kembo et al., 2020). These toxins are reported to cause economic losses, diseases, and even the death of humans and animals. Aflatoxin affects all poultry species. Young poultry, especially ducks and turkeys, are very susceptible to aflatoxicoses. The single dose $LD_{50}$ is 0.3 (mg/kg bw) for ducklings, and 6.0–16.0 (mg/kg bw) for chickens (*Reddy et al.*, 2018). The regulation limits of $AFB_1$ in completed poultry diets vary with poultry species, age and geographical locations/countries. As a general rule, the maximal allowed for growing poultry is a 20 µg/kg diet. Fungal growth and subsequent mycotoxin formation is dependent on a range of factors including seasons, location of grain cultivation, drought and time of harvest. Long term analysis of grain and feed samples worldwide has indicated that it is possible to have grains with extremely high concentrations of mycotoxins, although the overall mycotoxin contamination is low, (Streit *et al.*, 2013). Mycotoxins produce a variety of diseases, collectively called "mycotoxicoses," directly or in combination with other primary stressors such as pathogens (Raju and Devegowda, 2000). The contamination of feed with mycotoxins is a global concern, resulting in adverse effects on productivity and animal health and therefore, a great economic loss.

**The primary mechanisms through which mycotoxins affect animals are**

- Reduction of feed intake
- Reduced nutrition (reduced nutrient content of the feed, reduced nutrient absorption and altered nutrient metabolism)
- Immunosuppression
- Mutagenicity
- Teratogenicity
- Cellular death

Various factors, including feed quality, environmental conditions, and the presence of in the feed, can impact the delicate balance of the avian gut. Toxin binders in poultry feed (a group of feed additives) are designed to mitigate the harmful effects of mycotoxins and other contaminants and play a pivotal role in enhancing gut health in poultry.

**Types of Toxin Binders in Poultry Feed**

Toxin binders generally used in feeds can be broadly categorised into two types based on their mode of action viz. adsorbents and modifiers.

**1. Adsorbents:**

Common adsorbents include activated carbon, bentonite clay, zeolites, and aluminosilicates. These materials have a high surface area and can effectively adsorb mycotoxins, preventing them from entering the bloodstream.



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**2. Modifiers:**

Modifier toxin binders in poultry feed work by altering the chemical structure of mycotoxins, rendering them less toxic or non-toxic. This type of binder includes substances like hydrated sodium calcium aluminosilicate (HSCAS) and certain yeast cell wall components. Modifiers may also enhance the excretion of mycotoxins from the body.

**Mechanism of Toxin Binders in Poultry**

Toxin binders exert their beneficial effects through various mechanisms that contribute to improved gut health in poultry. The top mechanism of toxin binders in poultry include:

1. **Adsorption of Mycotoxins:** Adsorbent binders physically bind to mycotoxins, preventing their absorption in the gastrointestinal tract. The high surface area of adsorbents facilitates the binding process, effectively sequestering mycotoxins and preventing their systemic circulation.
2. **Chemical Modification:** Modifier binders may chemically modify mycotoxins, reducing their toxicity. This modification can involve altering the chemical structure of mycotoxins to render them less harmful to the bird.
3. **Enhanced Excretion:** Some toxin binders facilitate the excretion of mycotoxins from the body, minimising their accumulation in vital organs. This mechanism helps prevent the long-term negative effects of mycotoxin exposure.

**Mycotoxins in poultry feed can have a number of negative effects on the health and performance of poultry which includes:**

- **Decreased weight gain**: Mycotoxins can directly affect a bird's appetite, causing them to refuse to eat or root through their feed. Even a small drop in daily feed intake can lead to significant performance losses, such as decreased weight gain and can cause poor weight gain in poultry.
- **Reduced egg production**: Mycotoxins can reduce egg production by causing a decrease in protein synthesis. This can be due to liver tissue degeneration from exposure to mycotoxins like aflatoxin, ochratoxin, T2, and DON.
- **Organ damage**: Aflatoxins mainly AFB1 are highly absorbed in the gastrointestinal tract of poultry (90%) and are well known for their carcinogenic effect which can affect any organ or system, and can damage the liver, kidneys, and gastrointestinal tract of poultry.
- **Immune system impairment**: Mycotoxins can affect all parts of the immune system, including innate, cell-mediated, and antibody-mediated systems. This makes animals more susceptible to bacterial, viral, and protozoan infections Mycotoxins can negatively impact the immune system, making poultry more susceptible to disease and pathogens.



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- **Hatch defects**: Mycotoxins reducing fertility, egg quality and immunity in the broiler-breeder and causes negative consequences for the progeny of these birds. Mycotoxins can increase the number of embryonic deaths during hatching, thereby causes hatch defects, such as lower hatchability and an increased number of rejected day-old chickens.
- **Other effects**: Mycotoxins can also cause poor feed efficiency, increased liver fat, changes in organ weights, reduced serum protein levels, carcass bruising, poor pigmentation, and loss of appetite. Mycotoxins can impair the digestive process, which can lead to malnutrition and affect the quality of feathers. Mycotoxin also lead to rickets, tibial dyschondroplasia, urate crystals, reproductive disorders, skeletal abnormalities etc.

**Occurrence of Mycotoxins in Poultry**

1. **Sources:**
    - Mycotoxins are produced by molds, primarily from the **Aspergillus**, **Fusarium**, and **Penicillium** species. These molds can contaminate feed ingredients during growth, harvest, storage, and transportation.
2. **Common Mycotoxins:**
    - **Aflatoxins:** Highly toxic, produced by *Aspergillus flavus* and *Aspergillus parasiticus*. producing four main types: AFB1, AFB2, AFG1, and AFG2. Recognized as highly toxic mycotoxins, AFB1 is notably identified as a potent hepatocarcinogenic agent.
    - **Fumonisins:** Fumonisins (FBs), typically classified as Fusarium toxins, are produced by various species within the Fusarium genus, notably F. verticillioides and F. proliferatum. The primary toxins include FB1, FB2, FB3, and FB4, with FB1 recognized as the most prevalent and toxic.
    - **Zearalenone:** Zearalenone (ZEA) is a mycotoxin produced by various species of Fusarium fungi, commonly found in grains such as maize, wheat, barley, and oats. ZEA can contaminate animal feed and, through it, human food, posing health risks to livestock and humans alike. In animals, ZEA consumption can lead to reproductive disorder and infertility.
    - **Deoxynivalenol (DON):** Known as vomitoxin, produced by *Fusarium*, is a trichothecene mycotoxin primarily produced by Fusarium graminearum and commonly found in grains like wheat, corn, barley, and their by-products. It significantly impacts monogastric animals, notably pigs and poultry, through contaminated feed.



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- **Ochratoxin:** Produced by *Aspergillus* and *Penicillium* species. Meanwhile, ochratoxin A (OTA), a potent nephrotoxin, induces renal toxicity and is associated with carcinogenic, teratogenic, immunotoxic, and potentially neurotoxic effects.

3. **Factors Influencing Occurrence of mycotoxin:**

- **Environmental Conditions:** High humidity and along with high temperature favours mold growth. Mold needs a relative humidity (RH) of at least 70% for a prolonged period to grow. High humidity indicates a high level of moisture in the air.
- **Storage Conditions:** Poor storage practices can lead to contamination with mycotoxin. If the grains are stored on damp floor, then chances of contamination are high. Mycotoxins can continue to accumulate in wet grain, so it's important to dry grain before storing it. Remove damaged grain, as it can cause airflow problems during storage leading to mycotoxin contamination.
- **Feed Ingredients:** Certain grains, especially corn and wheat, are more susceptible. Proper care should be taken in different steps. Proper cleaning and drying to reduce the moisture content of harvested grain is essential to reduce mycotoxin content.

**Control Measures for Mycotoxins**

1. **Prevention Strategies:**
   - **Good Agricultural Practices (GAP):** Implement proper planting, harvesting, and storage techniques to minimize mold growth.
   - **Field Monitoring:** Crops should be tested regularly for mycotoxin contamination before harvest to minimise the contamination.
2. **Storage Management:**
   - **Humidity Control:** Maintain low moisture levels in storage facilities to inhibit mold growth. Maintaining indoor relative humidity below 60% will effectively control mold growth.
   - **Temperature Control:** Store feed in cool conditions to reduce the risk of contamination. High temperatures and humidity increase the risk of fungal growth and mycotoxin production. To minimize mycotoxin contamination, feed should be stored at a low temperature whenever possible.
3. **Testing and Surveillance:**
   - **Regular Testing:** Conduct routine testing of feed ingredients for mycotoxins using reliable methods (e.g., ELISA, HPLC).



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- **Surveillance Programs:** Establish monitoring programs to detect mycotoxin levels in feed.

4. **Use of Mycotoxin Binders:**
   - Incorporate mycotoxin binders (e.g., bentonite clay, activated carbon) into feed to adsorb and neutralize mycotoxins, preventing their absorption in the system, thereby the adverse effect can be reduced.
5. **Diet Formulation:**
   - **Nutritional Balance:** while formulating diets care should be taken to ensure a well-balanced healthy diet for the bird that supports the nutrient requirement, boosting immune system and minimizes the adverse effects of mycotoxins.
   - **Addition of Antioxidants:** Use antioxidants to help mitigate oxidative stress caused by mycotoxins.
6. **Enzyme Supplementation:**
   - Consider using enzymes that can degrade specific mycotoxins in the gastrointestinal tract such as **manganese peroxidase a** microbial enzyme that can degrade mycotoxins such as AFB1, ZEN, DON, and fumonisin B1 and laccase a microbial enzyme that can degrade mycotoxins such as AFB1 and ZEN.

**Conclusion**

Effectively managing the occurrence of mycotoxins in poultry is crucial for ensuring bird health and productivity. Implementing comprehensive control measures, from prevention and monitoring to the use of mycotoxin binders, can significantly reduce the risks associated with these harmful compounds. Regular education and training for poultry producers are also vital to enhance awareness and practices related to mycotoxin management.

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