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Trends and Advanced Strategies in Mycotoxin Risk Management

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Abstract: Mycotoxins are secondary metabolites produced by fungi under favorable environmental and climatic conditions. Occurrence of mycotoxin contamination is affected by different conditions in the field, during harvest, storage and in the farm environment. Common mycotoxins observed in feed raw materials are aflatoxins, zearalenone, trichothecenes, fumonisins and ochratoxins. Very often multiple mycotoxin contamination is observed in the field. This causes serious problems in animal production, affecting performance, reproduction and immunosuppression, which results in potential vaccination failure and higher medication costs. In the field, the most common practice to prevent and minimize the negative effects of mycotoxins is the use of mycotoxin binders. With this comes the false perception that all types of mycotoxins can be bound and that the animal will be less affected by the toxins. In reality, no mycotoxin binder caneffectively bind Fusarium mycotoxins, especially DON, T-2 and ZEN. It is expected that progress in the control of mycotoxin contamination will depend on the introduction of technologies for specific and effective detoxification. The utilization of biological detoxification agents, such as enzymes to biotransform mycotoxins, typifies such technology. Recently, a purified enzyme in fumonisin transformation, FUMzyme®, had been authorized by the EU as a proven mycotoxin deactivating agent.

Key words: mycotoxins, biotransformation, enzymes, adsorption, bioprotection

1. Introduction

Mycotoxins are highly toxic secondary metabolic products of various molds, mainly those belonging to the genera Fusarium, Aspergillus and Penicillium. It has been estimated that at least 300 of these fungal metabolites are potentially toxic to animals and humans. However, the most notorious — from an agricultural point of view — and thus extensively investigated mycotoxins are aflatoxin B1, zearalenone, deoxynivalenol, T-2 toxin, ochratoxin A and fumonisin B1. Their global occurrence is considered to be a major risk factor in livestock production.

The individual toxicity of mycotoxins is extremely variable. It not only depends on the physical and chemical properties of each toxin, but also on the level of intake, the duration of exposure, the animal species, sex, age, breed and physiological status, nutritional status, environmental conditions (including hygiene, temperature, air conditioning, humidity and production density) and the synergy which can occur between mycotoxins simultaneously present in feed. Mycotoxins are reported to be carcinogenic, genotoxic, teratogenic, dermatotoxic, nephrotoxic and hepatotoxic. Decreased performance, reproductive disorders and immunesuppression resulting, among other things, in a higher susceptibility to disease are also of major concern.

Several studies have shown that economic losses due to mycotoxins occur at all levels of food and feed production, including crop and animal production, processing and distribution. Even during favorable climatic periods, millions of dollars are lost as a consequence of crop contamination.

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Even though poultry is said to be less sensitive to most mycotoxins than other livestock species, mycotoxins negatively affect poultry in various ways. An increased mortality, as the final outcome of mycotoxicoses, is probably less economically damaging than most other effects, such as reduced productivity (due to reduced feed intake and live weight gain), greater risks of disease as a result of immunosuppression, damage to various organs such as the liver, and interference with reproductive performance in breeders. The latter is often goes undetected at farm level, resulting in great losses to the poultry producer and reduced profitability of his operations.

Scientific research has shown that no single strategy can be effective in controlling multiple mycotoxins. A comprehensive approach combines three different strategies: adsorption — the elimination of toxins, biotransformation — the elimination of toxicity, and bioprotection — the elimination of toxic effects.

The most effective way to counteract fumonisins is via enzymatic biotransformation, the highly specific and irreversible conversion of mycotoxins into non-toxic metabolites. FUM*zyme*® is the first purified enzyme that is capable of converting fumonisins into non-toxic, hydrolysed fumonisin B1 (HFB1). Scientific studies demonstrate that HFB1 does not cause intestinal or hepatic toxicity and does not induce major changes in the sphingolipid metabolism (Grenier et al., 2012).

2. Effect of FUMzyme® on Broiler Chicken Fed Diets Contaminated with Fumonisins

An experiment was conducted in broiler chickens fed diets contaminated with fumonisins in order to study the effect of FUM*zyme*® on fumonisin detoxification. Seventy five broiler chickens (Ross 308, initial weight: 38 g) were allocated to three experimental groups of 25 animals each, with five replicates per group (five birds per pen). In the course of the whole trial period all animals had free access to feed and water. Fumonisins (FUM) contamination level was 15 ppm, FUM*zyme*® was added in a concentration of 15 units/kg feed for 14 days. Fecal samples were collected per pen on day 14 of the trial. All animals were weighed at the beginning and at the end of the trial, feed intake was recorded as well.

The experimental design is shown in Table 1.

Parameters evaluated:

- Concentration of FB1 and HFB1 in feces [µg/g fresh sample].
- Performance: body weight, feed intake, FCR, weight gain.

3. Results

FUM*zyme*® significantly lowered the FB1 content in feces compared to the FUM contaminated group without additive ($P < 0.05$). The metabolite HFB1 was significantly elevated in the FUM + FUM*zyme*® group showing effective biotransformation by FUM*zyme*® (Fig. 1).

Table 1 Experimental design.

Experimental group	Number of animals	FUM [ppm]	FUM*zyme*® [U/kg]
Control	25	--	--
FUM	25	15	--
FUM + FUM*zyme*®	25	15	15

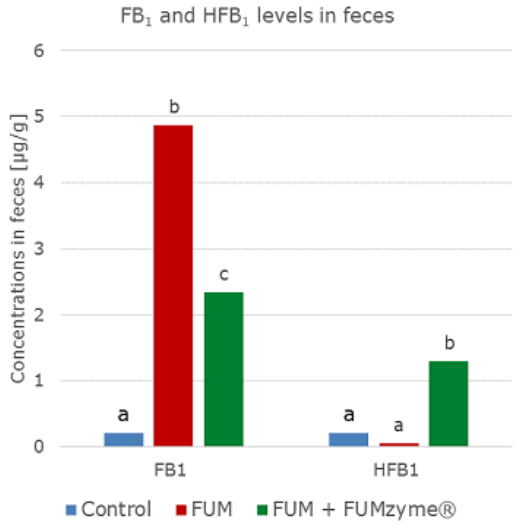

Fig. 1 Average concentration of FB1 and HFB1 [µg/g] in feces of broiler chicken a, b, c differences are statistically significant ($P < 0.05$).

There were no differences between the groups regarding performance (weight development, feed consumption) under these controlled environmental conditions.

4. Conclusion

The results of this trial demonstrate that FUM*zyme*® applied at a concentration of 15 Units/kg feed lead to an effective biotransformation of FB1 to HFB1 in broiler chicken.

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