Effect of mycotoxins on the utilisation of dietary nutrients

Harmful effects of mycotoxins in animals are widely known and well documented. These range from growth and feed conversion impairment, decreased resistance to pathogens, and death. Despite the adverse effects of mycotoxins on health and the economic losses associated with them, many producers focus on performance results. They are easier to calculate compared to estimation of the effect of mycotoxins on health.

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Negative effects of mycotoxins on feed conversion are calculated per feed unit. Data concerning the impact of mycotoxins on utilisation of main feed nutrients (such as dry matter, protein, fat, etc) obtained in metabolic studies are limited.

Apoptosis and modulation of intestinal transporters

Intestinal cells are the first cells to be exposed to mycotoxins at higher concentrations than other tissues. In addition, several mycotoxins, for example trichothecenes and ochratoxins, specifically target high protein turnover and activated cells in the gut epithelium.

Therefore, intestinal investigations have gained significant interest over the last decade, and some publications have demonstrated that mycotoxins are able to compromise several key functions of the gastrointestinal tract. These include impaired nutrient absorption, decreased surface area available for nutrient absorption, modulation of nutrient transporters, and loss of barrier function.

Trichothecenes can cause harmful injury to the mucosa, destroying cells on the tips of villi and radiomimetic injury to rapidly dividing crypt epithelium.

It is well documented that among the trichothecenes, high levels of dietary DON can induce apoptosis of some differentiated epithelial cells. However, it was later proven that DON effects are due to a specific modulation of the activity of intestinal transporters rather than a consequence of non-specific cell damage.

In differentiated HT-29-D4 cells, the uptake of nutrients is specifically affected, depending on both the nutrient studied and the mycotoxin concentration.

Other trichothecene mycotoxins such as fusarenon-X and T2-toxin have also been shown to inhibit nutrient absorption in animals. Similar conclusions could be drawn from the study of ochratoxin A, another mycotoxin that inhibits protein synthesis.

It was found that increasing dietary nutrients such as protein, energy (fats and carbohydrates), and vitamins in the diet may help to reduce the mycotoxin effect on performance. However, the level each nutrient has to be increased to counteract the effect of the mycotoxins on performance is not known.

Parameter	Control	Mycotoxins
Livability (%)	97.4[a]	81.6[b]
Average daily gain (g)	57.8[a]	49.5[b]
Feed:gain	1.67[a]	2.09[b]

Different superscripts above the row mean statistically significant differences ($p<0.05$)

Table 1. Performance of broiler chickens after 35 days.

Metabolic proof

One of the aims of Nutriad's study in broilers was to understand the impact of a mixture of mycotoxins on the utilisation of dietary nutrients.

A completely randomised experimental design with three mycotoxin types (ochratoxin A, T2-toxin and fumonisin B1) was used. A total of 76, day-old male Cobb-Avian-48 broiler chickens, were allocated into two groups with four replicates of 10 birds in each group. The birds were fed dry feed ad libitum.

All birds received a 'blanco' diet without mycotoxins until five days of age.

Experimental diets were then given starting at day six. The experimental period was five weeks (35 days) long.

The groups were fed as follows:

- Group 1: Control given feed containing mycotoxins below detection limits.
- Group 2: Given feed contaminated with Fusarium mycotoxins; 410ppb T-2 toxin, 160ppb ochratoxin A and 12.7ppm fumonisins supplied as fungal biomass based on maize containing toxic strains of four cultures of fungi (Aspergillus flavus, Fusarium sporotrichiella, F. poae and F. moniliforme) and their exotoxins.

At the end of the experimental period, three birds from each group were placed in individual metabolic cages and allowed to adjust for five days. Thereafter, faeces were collected for three days.

During the experimental period, feed intake, body weight and mortality were measured. Based on these parameters, the feed conversion ratio (FCR) was calculated. The ability to digest dry matter, crude protein, crude fat, crude fibre and crude ash was also observed.

In the second group, mycotoxins significantly impaired all performance

Continued on page 13

Continued from page 11
parameters studied (Table 1). The feed utilisation was severely affected by mycotoxins (2.09 versus 1.67 in the control group). Table 2 shows how much the digestibility of main nutrients was affected by mycotoxins.

Utilisation of all nutrients studied was significantly affected by the mycotoxin contamination.

Utilisation of the dry matter and energy of the diet was reduced by mycotoxins by 14.1 and 9.7% respectively.

Consequently, significantly more nutrients passed through the small intestine and caeca undigested and were excreted as such.

Among the measurable parameters, the digestibility of crude fibre was the most affected (-36.1%) followed by crude protein (-8.2%) and crude fat (-5.6%).

Parameter	Control	Mycotoxins
Dry matter (%)	72.6±0.6[a]	62.4±2.1[b]
Crude protein (%)	92.0±0.7[a]	84.5±2.0[b]
Crude fat (%)	81.9±1.9[a]	77.3±1.7[b]
Crude fibre (%)	25.5±0.3[a]	16.3±0.8[b]
Gross energy (Q) (%)	68.8±2.1[a]	62.1±0.7[b]
	Different superscripts above the row mean statistically significant differences ($p<0.05$)	

Table 2. Faecal digestibility of feed nutrients by finishing broilers.

Prevention of lower nutrient uptake when mycotoxins are present

Interestingly, mycotoxins do not necessarily reduce absorption of all nutrients. In a study with broiler chickens, it was observed that feeding a DON and fumonisin contaminated diet significantly increased the apparent ileal methionine digestibility compared to chickens fed a control diet (82% versus 72%, respectively; P=0.02).

The specific effect of each mycotoxin on the nutrient uptake can vary between animal species.

For example, whilst trichothecenes can have a greater effect on the absorption of different nutrients in monogastric animals via modulation of the activity of intestinal transporters as well as via non-specific cell damage, in ruminants they lead to a possible negative impact on the biological activity of micro-organisms and consequently on the ruminant digestion of fibre. Some researchers have found that increasing dietary nutrients such as protein, energy (fats and carbohydrates), and vitamins in the diet may help to reduce the effects of mycotoxins.

The results of Nutriad's study support the logic behind this suggestion. However, lower digestibility can lead to increased levels of undigested nutrients in the distal parts of the intestine leading to the pathogen colonisation.

Conclusion

The inclusion of mycotoxin deactivating products like UNIKE Plus with proven efficacy into contaminated feed can decrease the negative effects of the mycotoxins resulting in an improvement in productivity of broilers as well as digestibility of the feed.

Previous experiments have shown that birds fed a diet containing the mycotoxin deactivator have a more effective nutrient utilisation process and show better growth rates, resulting in additional feed savings. ■

References are available from the author on request