Binding of nutrients in the feed: all binders are not equal

by Neovia, InVivo NSA Group, BP 394, 56009 Vannes cedex, France.

The solution against mycotoxins forms an entire part of the biosecurity prevention plan in feed mills and farms. Mycotoxin binders can be called 'simple binders' when they contain only a binding component as clay for example. They can also be called 'complex binders' when they contain other additional elements that can work in synergy to reduce the detrimental effects of mycotoxins on animals. The objective of a 'mycotoxin binder' is to avoid the transfer of toxins through the digestive barrier into the blood of the animals, by sequestering it, and eliminating it in the faeces.

The mechanism of mycotoxin binding is complex, and may be based on ionic interactions between the mycotoxin and the clay: clays as bentonite are layered aluminosilicates, composed of tetrahedral silicon sheets and octahedral aluminium sheets, the negatively charged octahedral sheet being fixed to the two tetrahedral sheets by countervailing oxygen cations (Fig. 1 and Fig. 2). The positively charged mycotoxins like aflatoxins can be fixed to clay sheets by exchanging a cation with it.

De Oliveira et al., (2005) showed that, in addition to ionic interactions, hydrophobicity of tetrahedral sheets of clays can explain the binding of positively charged elements. Finally, other physical characteristics, like specific surface, are also involved in the binding capacity of clay mycotoxin binders. Consequently, each binder has its own specific binding capacity that can vary a lot according to its origin and treatments (chemical, physical or thermic). Thus, two clays, even from the same family, like two bentonites from different origins,

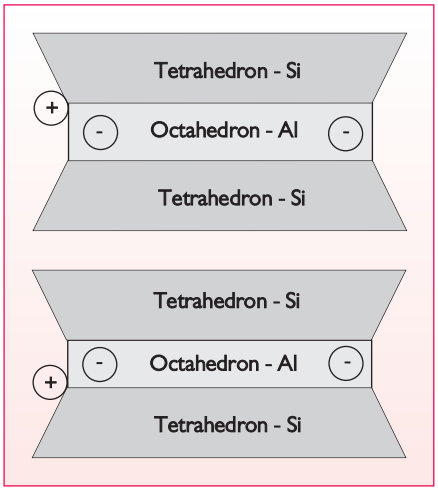

Fig. 1. Clay mineral particles.

can have different efficacy and be more or less selective towards mycotoxins.

In fact, due to this sequestering mode of action, many people are reluctant to use such products. Effectively, nutrients can sometimes also be bound, when binding properties of the binder are not specifically targeted for mycotoxins.

This undesirable binding can lower the efficiency against mycotoxins and, above all, reduce the availability of essential nutrients for growth. They can also alter the efficacy of medicinal substances contained in the feed, as coccidiostatic products for example.

S. J. Gray et al., have proved for example in 1998 that a level of 0.5% of the tested bentonite in the diet could reduce the efficacy of monensin and salinomycin in chicks. Small protein molecules with a positive charge can also be intercalated into the interlayer of montmorillonite through cation exchange.

The EU allows a maximum incorporation of clay of 2% in feed, in order to bind aflatoxin B1 (implementing regulation number 1060/2013 concerning the use of bentonite as a additive in feed of all animal species). But even at lower quantities, the risk of binding nutrients exists. For example, EFSA, in its first scientific opinion on the safety and efficacy of bentonite as a feed additive, warned about the potential binding of manganese, an essential trace element, when bentonite is used at a dosage higher than 0.5% in the feed.

In 2010, EFSA published a statement on the establishment of guidelines for the assessment of additives, from the functional group 'substances for reduction of the contamination of feed by mycotoxins'.

In this statement, EFSA recommended to measure the apparent digestibility of crude proteins, vitamin B1, vitamin A and a coccidiostat on broilers in the feed when it is supplemented by a mycotoxin binder, to prove its safety towards potential nutrients and medical substances binding.

In order to prove the safety of the use of clay regarding nutrients and medicinal substances availability, and to follow the EFSA recommendation, Neovia, the additive brand of InVivo Nutrition and Animal Health ran a digestibility test on 48 roosters on its French experimental station of Saint-Nolff, France. By doing an in vivo trial instead of in vitro, the potentially false extrapolations of the complexion of the nutriment by the binder measured in vitro are avoided, and accurate results are obtained on the potential binding of nutriment really occurring in the animals.

Two different diets were compared in this trial: a control diet composed of 100% standard broiler feed without any mycotoxin binder, and a second diet composed of 99% standard broiler feed + 1% clay (a mix of bentonite and montmorillonite, used in T5X range, with a level of 10kg/ton of feed, the maximum dosage recommended by Neovia). The digestibility of four elements was measured: vitamin B1 (thiamine – hydrosoluble), vitamin A (liposoluble), crude protein and narasin (coccidiostatic). For each diet, 12 intact adult roosters were used to measure the digestibility of vitamin A, vitamin B1 and

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Table 1. Apparent digestibility of different components (%).

Chemical component	Control diet without binder	Control diet 99% + 1% binder	Difference	Significance
Narasin	96.3	96.6	+ 0.3	NS
Vitamin B1	64.9	63.0	- 1.9	NS
Vitamin A	99.5	99.1	- 0.4	NS
Crude protein	78.4	79.3	+ 0.9	NS

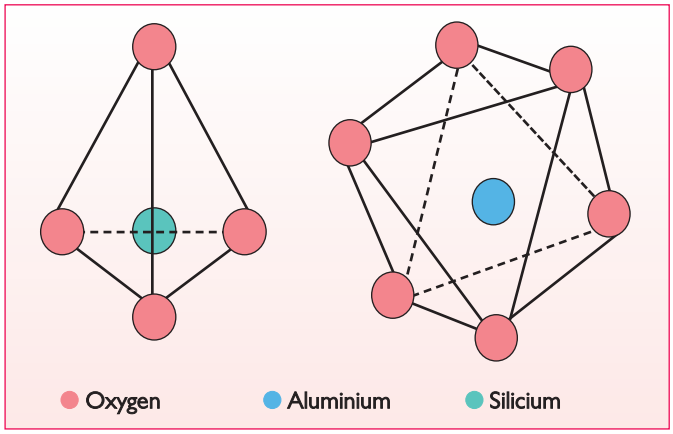

Fig. 2. Tetrahedral and octahedral particles.

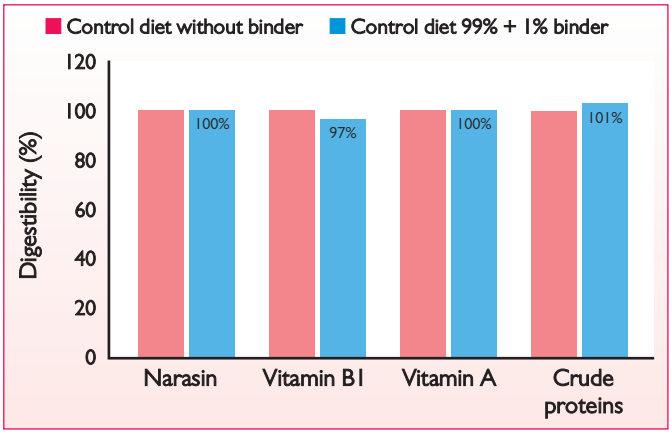

Fig. 3. Apparent digestibility compared to control diet (%).

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narasin. To avoid caecal fermentation and uric acid secretion and so have accurate results, 12 caecectomised adult roosters were used to measure the crude protein digestibility. All animals, located in individual cages, were force fed with no access to feed for the 24 hours before the trial and for the 48 hours after the gavage. After collecting the faeces, apparent digestibility of each component could be calculated following this formula: Apparent digestibility = (quantity of nutrient ingested – quantity of nutrient in dried faeces) / quantity of nutrient ingested.

After faeces drying and analysis, no difference could be observed between the two different diets, with or without mycotoxin binder (Table 1). A comparison with the control diet was also made (Fig. 3).

In this trial, the apparent digestibility of vitamin B1 and vitamin A, crude proteins and the anticoccidial narasin were not affected by the addition of the clay used by Neovia in its range of mycotoxin binder products, in comparison to a control group of roosters that did not consume any mycotoxin binder.

Nevertheless, as seen before, clay characteristics can vary a lot according to their origin and treatments (chemical, physical or thermic), so no general conclusion can be made on all types of clays and such experimentation has to be done for each ingredient which claims a binding property. Moreover, all mycotoxin binders are not only composed of clays and some binding agents, as charcoal may sometimes be used for its great binding properties, with no regard to non-specific binding.

As the use of mycotoxin binders is very frequent and forms an entire part of the safety prevention plan, particular attention must be paid to composition, in order to maintain the best feed quality and nutritional values, preserve medicine efficacy, and thus optimise the genetic potential of the bird. This is what Neovia guarantees to their customers: efficacy, safety and expertise. ■

References are available from the author on request