All clays are not created equal

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Practical methods to detoxify myco-
toxin contaminated grain or feed on a
large scale and in a cost effective man-
ner are not currently available. At present,
one of the most practical approaches con-
­sists of using adsorbent materials in animal
diets to reduce the absorption of mycotox-
ins from the gastrointestinal tract.
Clays are an important group of products
that have been used successfully worldwide
to reduce mycotoxicosis; and all commercial
anti-mycotoxin additives or mycotoxin inac-
tivators available in the market are clay
based products.

Complex aluminosilicates

Clays are complex and widely diverse alumi-
nosilicates with a variety of functional prop-
erties, but they are often grouped into a
single category.
This is very misleading since there are
many types of clays, which are completely
different from one another.
Many types of clays do not capture myco-
toxins; some can absorb water, others can
absorb ammonia, and only certain clays can
absorb mycotoxins.
The first effective mineral adsorbent was
described as hydrated sodium calcium alu-
minum silicate (HSCAS), and others have
subsequently used this nomenclature.
Because HSCAS is a generic description, it
does not specifically define the material of
use. The majority of mycotoxin binding
products are classified as montmorillonite,
belonging to the phyllosilicate group, which
is composed of layers of aluminum and sil-
icon connected in a 1:1 or 2:1 arrangement.
Not all clays that adsorb mycotoxins are
equally effective in protecting animals against
the toxic effects of mycotoxins. Even some
montmorillonite adsorbents are not always
the best binders. Furthermore, the adsorp-
tion ability of similar clays may vary from
one geological deposit to another.
Besides their origin, formation and struc-
ture, clays can vary in chemical composition,
surface acidity (pH), electrical charges
(polarity), distribution of exchangeable
cations, and porosity and expansibility char-
acteristics.
Despite all these differences, there is no
significant correlation between any single
physical or chemical property and the myco-
toxin binding capacity of clays.
Therefore, the effectiveness of a myco-
toxin adsorbent is tested by conducting
evaluations in vitro and in vivo to demon-
strate a statistical significant response in pre-
venting mycotoxicosis.
The dosage of the adsorbent and the level
of the mycotoxin used in these tests must
always be reported. Also, it is important to
demonstrate the innocuity of the product
when it is evaluated without the presence of
mycotoxins.

Experimental design

The in vitro test must be conducted with
high performance liquid chromatography
(HPLC) using a methodology using two
types of solutions: one of pH 3 and another
of pH 6, mimicking the gastric and the
intestinal juices.
For the in vivo test there is a standard
experimental protocol consisting of four
treatments: a control without mycotoxins; a
control with adsorbent; a control with
mycotoxin; and one with mycotoxin plus
adsorbent.
Additional treatments can be added to this
experimental design, such as different testing
levels of the adsorbent. The amount of an
adsorbed mycotoxin is difficult to calculate;
therefore in the in vivo trial, the efficacy of
adsorption has to be determined by the
bird’s performance (body weight gain, feed
consumption and feed efficiency) and the
target organ protection. It is important to
evaluate the target organ(s) since they
reflect the specific damage of the myco-
toxin.
It is also necessary because some adsor-
bents base their effectiveness on a positive
effect on performance, which is a result of
the presence of enzymes, beneficial bacteria,
yeast and/or immuno-stimulant in the com-
position of those products, and not myco-
toxin adsorption.

Evaluating effectiveness

The relation between in vitro evaluation and
in vivo effectiveness cannot always be con-
­ﬁrmed. In evaluations done by Dr Mallmann
and collaborators in LAMIC on 58 AMA for
different toxins and species, little more than
55% of AMA approved in vivo, had an
adsorption greater or equal to 90% at pH 3
and 6. For AMA approved in vivo, more
than 50% had an adsorption less than 70% at
pH 3 and 6 (Fig. 1).

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There was no significant correlation between in vitro and in vivo evaluations when the data of those 58 in vitro and in vivo evaluations were submitted to a linear regression analysis.

The greatest correlation found was in broiler chickens, at pH 6 with fumonisins (P<0.07 and R=-0.55), followed by correlation for swine at pH 6 with aflatoxins (P<0.1 and R=0.55). These analyses showed that some products that were not very effective in laboratory conditions can often function satisfactorily in the in vivo trials. It is evident from this data that the results obtained from in vitro evaluations are not sufficient to prove the efficiency of an AMA. Therefore, statistical satisfactory results from the in vivo test are necessary to determine the efficacy of an AMA.

**Aflatoxin adsorption**

During the last 20 years, various scientific studies have demonstrated that some aluminosilicates are very effective in preventing aflatoxicosis. In the program for approval of anti-mycotoxin additives, conducted by LAMIC in Brazil, 16 out of 32 products evaluated were proven to be efficacious against aflatoxin in broiler chickens. All the effective products are or contain clays. The majority of the clays that significantly ameliorate the toxic effects of aflatoxins have been reported to be effective at an inclusion rate of 5 or 10kg per metric ton of feed. Only a few, including Myco-Ad, significantly prevented aflatoxicosis at 2.5kg/mt of feed. Recently, Myco-Ad has become the first and only product approved by LAMIC against aflatoxin in three different species: poultry, swine and cattle.

Very few products are effective against more than one type of mycotoxin; among these, Myco-Ad is exceptional because it has been scientifically proven that it ameliorates the deleterious effects of aflatoxin, in the three species mentioned above; and prevents the toxic effects of ochratoxin, T-2 toxin and fumonisin in broiler chickens.

**Purified phylosilicates**

In recent years, special proprietary processes have been developed for the production of purified and activated phylosilicates with the objective of producing adsorbents capable of binding fusicotoxicins such as zearalenone, deoxynivalenol, fumonisins, and T-2 toxin. After the process, these phylosilicates become very light, showing a much lower density and particle size than regular clays. Normally, these products have been effective when added to animal diets at a very low dosage (0.5 to 2.0kg/mt). One of the few purified phylosilicates is Myco-Ad A-Z which has been scientifically proven to be efficacious in preventing the toxic effects of T-2 toxin in broiler chickens, and fumonisin, zearalenone and deoxynivalenol in pigs.

**Conclusions**

Clay based products are the most effective mycotoxin adsorbents. However they are diverse aluminosilicates with a variety of properties. Many types of clays do not capture mycotoxins; some can absorb water, others can absorb ammonia, and only certain clays can adsorb mycotoxins. There is no significant correlation between any single physical or chemical property and the mycotoxin binding capacity of clays. Therefore, the effectiveness of a mycotoxin adsorbent has to be evaluated by conducting in vivo tests using a scientific experimental design which measures the beneficial effects of the product on animal performance and on the target organ(s) affected by the mycotoxin being studied. Scientific studies have demonstrated that some aluminosilicates are very effective in preventing aflatoxicosis at an inclusion rate of 5 or 10kg/mt of feed; and only few, can do it at 2.5kg/mt.

Very few products are effective against more than one type of mycotoxin. Recently, special purified phylosilicates have been developed, which are capable of binding fusicotoxicins such as zearalenone, deoxynivalenol, fumonisins, and T-2 toxin at very low inclusion rate (0.5-2.0kg/mt).