TRILOGY

Trilogy Analytical Laboratory

WHITE PAPER

Mycotoxin Binders

An Overview of Mycotoxin Binder Analysis

Mycotoxins pose serious health risks to both humans and animals. In this white paper we'll explore the science behind mycotoxin binders and examine what goes into a binder analysis study.

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Mycotoxin Binders

An Overview of Mycotoxin Binder Analysis

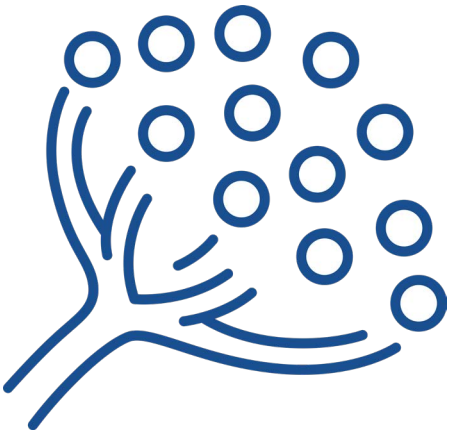
Introduction to Mycotoxins

Mycotoxins, originating from the metabolic byproducts of molds, present considerable health hazards to both human and animal populations. The potential risks to animals exhibit significant variability, contingent upon factors such as the specific mycotoxin involved, as well as the age and species of the affected organism. It is noteworthy that annual economic losses attributable to mycotoxin contamination and mycotoxicosis attain a staggering magnitude.

Animal producers may encounter a spectrum of challenges, including suboptimal feed conversion rates, reproductive anomalies, compromised immune responses, general health adversities, and, in extreme cases, mortality, as a direct consequence of mycotoxin contamination within their livestock's dietary provisions.

The seven primary mycotoxins of concern for feed safety are:

1. Aflatoxins
2. Ochratoxin A
3. Zearalenone
4. Deoxynivalenol (DON, commonly known as Vomitoxin)
5. T-2 Toxin
6. Fumonisins
7. Patulin



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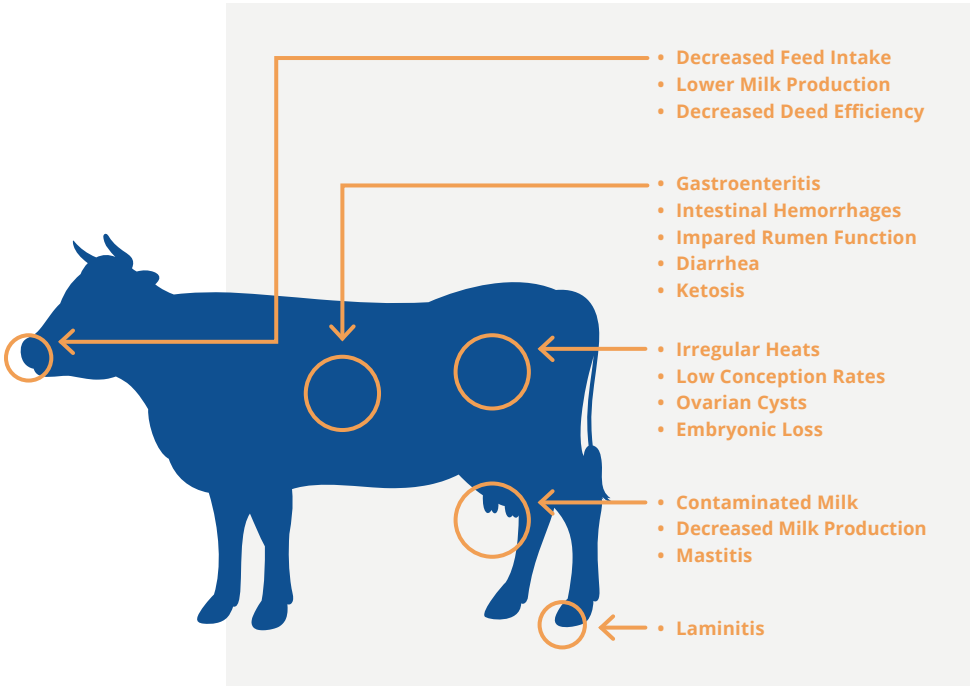
Effects of Mycotoxins on Livestock and Poultry

Mycotoxins, produced by molds, pose significant health risks to humans and animals. Risks to animals can vary widely depending on the toxin and the age and species of the animal. Each year, the economic losses due to mycotoxin contamination and mycotoxicosis are staggering.

Ruminants: *Figure 1*
Mycotoxin consumption can have a range of adverse effects on ruminants, which are animals with a specialized stomach that allows for the fermentation of feed. These effects can present as digestive disturbances that may manifest as decreased feed intake, reduced nutrient absorption, and impaired rumen function, reduced milk production in dairy cows, immune system suppression, reproductive problems such as reduced fertility rates and increased embryonic loss in breeding animals.

Figure 1: **Mycotoxins Impact in Ruminants**



Swine:
In the case of swine, mycotoxins can induce a range of issues, including pulmonary edema, fertility complications, instances of abortion, and a decline in overall reproductive health. These toxins may also trigger immune system complications and feed rejection, posing additional health concerns for farmers to address.

Poultry:
Poultry can also experience a range of effects when exposed to mycotoxin contaminated feed. Poor conversion rates leading to lower egg production, immune suppression, reproductive issues resulting in lower fertility rates and hatchability in breeding operations.

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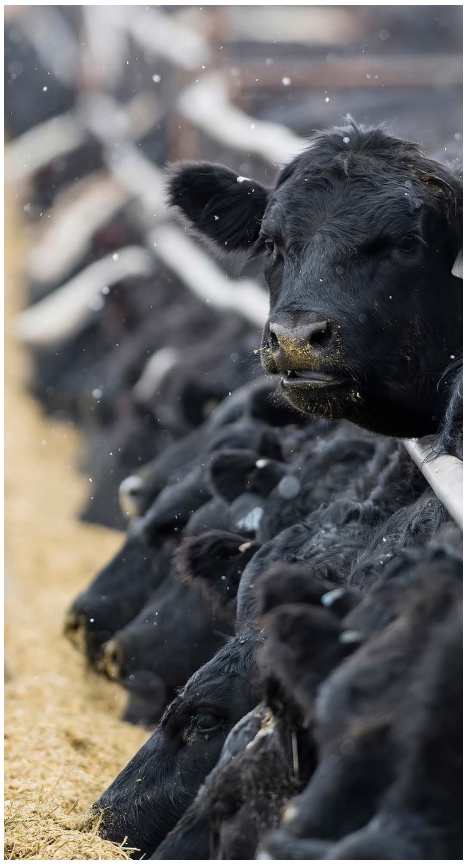
Types of Mycotoxin Binders

Mycotoxin binders are critical components incorporated into animal feed to protect animals from the harmful effects of mycotoxins. These toxins can contaminate feed and pose a significant health risk to livestock. Mycotoxin binders come in several types, each with its own method of mycotoxin management.



Inorganic Binders:
Inorganic mycotoxin binders include compounds like aluminosilicates, bentonites, clays, and zeolites. These materials physically adsorb mycotoxins in the digestive tract, preventing them from being absorbed into the animal's system. In essence, they act as a protective shield, trapping the toxins and allowing them to pass harmlessly through the animal's body.

Organic Binders:
Organic mycotoxin binders, such as yeast cell walls, have an organic nature and work slightly differently. They interact with mycotoxins to reduce their bioavailability, making them less harmful to the animal. The goal remains the same: to prevent toxins from being absorbed into the animal's system.

Toxin-Modifying Binders:
This group of binders takes a different approach. Instead of merely adsorbing mycotoxins, they actively modify the toxin's structure to render it non-harmful or minimally harmful. This approach is achieved using substances like natural microbial agents and enzymes. These "newest" binders are not only effective at mycotoxin control but are also often touted for their additional benefits, such as improving the animal's immune functions.

In the United States, the FDA has not yet approved specific mycotoxin binders for the purpose of mycotoxin removal in animal feed. The process of obtaining FDA approval for such products is both resource-intensive and financially demanding, often requiring extensive feeding trials and safety evaluations.

Due to the absence of FDA-approved designations for "toxin binders," mycotoxin binders in the U.S. are typically labeled under alternative categories. These labels include "flow agents," "digestive aids," "anticaking agents," "pellet binders," and other descriptive terms. This nomenclature reflects the diverse functions and benefits these binders offer, aside from their primary role in mycotoxin management.

Many binders are labeled with suggested inclusion rates, providing guidelines for the optimal amount to be included in animal rations. The recommended inclusion rate is crucial for achieving the desired mycotoxin binding effects without interfering with the animals' overall nutrition.

It's important to note that some binders are effective against specific mycotoxins, while others have broader capabilities, binding multiple mycotoxins simultaneously. The primary objective of a binder is to interact with mycotoxins in the digestive tract, forming stable bonds with the toxins. This process prevents the mycotoxins from being absorbed into the animal's system, allowing them to be safely eliminated from the body through waste products.

The use of mycotoxin binders, despite the absence of a specific FDA designation, remains a valuable strategy for livestock farmers to protect the health and well-being of their animals, ensure productivity, and maintain product quality.

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Mycotoxin binding analysis serves as a valuable screening tool in laboratory settings to assess a substance's capacity to bind toxins.

Laboratory Analysis

Mycotoxin binding analysis serves as a valuable screening tool in laboratory settings to assess a substance's capacity to bind toxins. While these tests are not intended to replace feeding trials, they play a pivotal role as a laboratory tool for several purposes:

Product Qualification:
Mycotoxin binding analysis is instrumental in the initial qualification of products that may have potential for effective toxin binding in a feeding trial setting. It helps identify candidates that warrant further investigation.

Quality Control Data:
These tests also function as a quality control measure. They can be used to evaluate materials that have already proven their efficacy in feeding trials. By analyzing new lots of these products, it ensures consistent performance and maintains product quality over time.

Efficiency and Cost-Effectiveness:
Mycotoxin binding analysis provides an efficient and cost-effective way to assess the toxin-binding capabilities of substances, streamlining the product evaluation process.

Risk Mitigation:
By identifying candidates with promising binding properties, this laboratory tool reduces the financial and logistical risks associated with conducting extensive feeding trials on a wide range of potential products.

Research and Development:
Mycotoxin binding analysis supports research and development efforts by helping researchers narrow down options for further investigation and refinement.

Mycotoxin binding analysis acts as a valuable pre-screening tool, helping to identify promising candidates for feeding trials, maintain product quality, and streamline the product development process. While it doesn't replace the need for feeding trials, it significantly contributes to efficient and cost-effective toxin-binding assessment in the laboratory.

Customizable Study Parameters for Analysis

At Trilogy Analytical Laboratory, the analysis of binders involves several critical parameters to ensure a comprehensive assessment of their performance. These parameters are carefully considered to provide valuable insights into the efficacy of the binders:

Inclusion Rate:
The inclusion rate of the binder is a fundamental parameter. It can reflect the suggested inclusion rate used in real-world applications, or it can be adjusted to higher or lower levels to gather additional data, helping to assess the binder's performance under different conditions.

Toxin Parameters:
Several decisions need to be made regarding the toxins to be tested, including:

Single or Multiple Toxins:
Determine whether to challenge the binder with a single specific toxin or multiple toxins to assess its effectiveness against various mycotoxins.

Selection of Toxins:
Choose the particular mycotoxin(s) that the binder will be tested against, based on relevance and potential exposure in the target animal species.

Toxin Concentration:
Establish the concentration of mycotoxin to be used in the test. This concentration reflects the amount of toxin that would be present in the animal's digestive system during the test, providing a realistic representation of toxin exposure.

Adsorption and Desorption pH Levels:
The adsorption and desorption pH levels play a critical role in the analysis. It is recommended to select pH levels that mimic the upper and lower digestive tract of the specific animal for which the binder will be used. This ensures that the binder's performance is assessed under conditions that closely resemble the animal's physiological environment.

By carefully considering these parameters, Trilogy Analytical Laboratory can conduct thorough analyses of binders, yielding valuable data on their toxin-binding capabilities and robustness under various conditions. This comprehensive approach ensures that the performance of binders is rigorously evaluated to meet the specific needs of the animal industry.

Multi-toxin Binder Analysis

Trilogy Analytical Laboratory provides a valuable service known as multi-toxin mycotoxin binder analysis, enabling manufacturers and end users to assess the efficiency of binders in adsorbing multiple toxins simultaneously. This analysis offers crucial insights into the binder's capacity to address complex mycotoxin challenges. To conduct this analysis, the following parameters are carefully determined:

Concentration of Toxins:
The concentration of mycotoxins to be included in the analysis is a pivotal parameter. It serves multiple purposes:

High Concentration: Manufacturers or end users can opt for a high concentration of toxins to challenge the binder's performance under severe conditions, simulating crop years with elevated mycotoxin contamination.
Low Concentration: Alternatively, a lower inclusion rate can be selected to assess how well the binder per forms in binding low levels of toxins, reflecting non-problematic years.

By choosing the concentration of toxins carefully, manufacturers and end users can gain a comprehensive understanding of the binder's efficacy across a spectrum of mycotoxin contamination scenarios. This approach helps in making informed decisions about binder selection and application in various agricultural contexts.

The pH levels chosen for the adsorption and desorption phases of the test are crucial in mycotoxin binder analysis. These pH conditions are typically selected to mimic the specific pH levels found within the animal's digestive tract. For instance, in the case of swine, the following pH conditions may be applied:

Adsorption Phase:
The pH level chosen for the adsorption phase typically reflects the conditions in the stomach, where the initial stages of digestion occur. This phase simulates the binder's interaction with mycotoxins under stomach-like pH conditions.

Desorption Phase:
The desorption phase is set to represent the pH conditions of the lower digestive tract in the intestines. This phase assesses the binder's ability to retain bound mycotoxins under conditions similar to the intestines, where there's a potential for toxins to be released from the binder.

By selecting pH levels that mirror the animal's digestive tract, the mycotoxin binder analysis provides insights into how the binder performs in the context of the animal's physiology.

Laboratory Analysis

The mycotoxin binder analysis process is an analytical series of steps that involve accurately assessing the binder's effectiveness. Here is an overview of the procedure:

1. Weighing the Binder: The mycotoxin binder is carefully weighed into a test tube in an amount that mirrors the chosen inclusion rate, reflecting the suggested rate for practical application.

2. Introduction of Toxins: The selected mycotoxin(s) are introduced to the test tube at the predetermined concentration levels, simulating the presence of toxins in the animal's digestive system.

3. Buffered Solution at Appropriate pH: A buffered solution with a pH chosen to replicate the initial digestive system pH is added to the test tube. This solution is essential for creating the right conditions for toxin-binding interactions.

4. Incubation (Digestive Phase): The test tube contents are allowed to incubate for several hours at a temperature selected to mimic physiological conditions in the animal's digestive system. This incubation process simulates the early stages of the digestive process.

5. Centrifugation: After incubation, the test tube is removed and subjected to centrifugation. This step helps separate the binder-toxin complex from the buffered solution.

6. Testing for Remaining Toxin: The buffered solution is then tested to determine if any toxin remains in the solution after incubation. This step provides information on the binder's ability to adsorb toxins during the digestive phase.

7. Re-suspension and Desorption Phase: The remaining binder, if any, is re-suspended in a buffered solution, this time reflecting the pH conditions of the lower digestive tract. The test tube is once again incubated under these conditions to simulate the lower digestive phase.

8. Testing for Toxin Retention: After incubation in the desorption phase, the buffered solution is tested to determine if the binder effectively retained the toxin or allowed it to be released. This phase assesses the binder's ability to retain toxins in the lower digestive conditions.

The combination of these phases—digestive and desorption—provides valuable insights into the binder's performance in a laboratory setting, helping assess its efficacy in binding mycotoxins under conditions that resemble those in the animal's digestive tract. This rigorous process ensures that manufacturers and end users can make informed decisions about the use of binders in real-world applications.

Result Interpretation

These tests are carried out in triplicate to ensure data accuracy and minimize experimental variability. The results are reported with key values: 'average adsorption' and 'average desorption,' derived from three separate adsorption and desorption analyses. The 'percent adsorption' reflects the binder's ability to adsorb mycotoxins during the digestive phase, while the 'percent desorption' indicates its capacity to retain or release toxins during the desorption phase. The most crucial value, the 'percent efficiency,' is calculated by subtracting the average desorption from the average adsorption. This percentage reflects the binder's overall efficiency in binding mycotoxins under laboratory-simulated conditions. A higher 'percent efficiency' signifies superior binder performance, offering valuable insights to manufacturers and end users for informed decision-making in real-world applications.

Here's an example illustrating the concept of percent efficiency in mycotoxin binder analysis:
Suppose a binder underwent testing and demonstrated an "average adsorption" of 99%, meaning it effectively adsorbed 99% of the mycotoxin introduced during the digestive phase. However, during the desorption phase, it only released 2% of the bound toxin. In this case, the calculated "percent efficiency" would be 97%. This value reflects the binder's performance in binding and retaining 97% of the toxin introduced to it under laboratory conditions. Such a high percent efficiency indicates the binder's ability to mitigate mycotoxin risks, making it a robust choice for practical applications.