

Efficiency of the complex mycotoxin adsorbent «Galluasorb» in combined mycotoxicosis of pigs

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Abstract. The paper presents the results of studying the efficiency of the method for preventing T-2, aflatoxin, DON- and zearalenone toxicosis in pigs using the complex mycotoxin adsorbent "Galluasorb". It is shown that as a result of including "Galluasorb" in pig feed, naturally contaminated with four mycotoxins at once, at the rate of 2.5 kg per ton of feed, a protective effect was observed, which was expressed in an increase in weight gain, feed consumption, a decrease in its conversion, normalization of the clinical status and morpho-biochemical blood parameters. Thus, on the 30th day of the experiment, the absolute increase in live weight in piglets receiving the main diet with mycotoxins with the addition of "Galluasorb" was 13.7 kg, while in piglets of the toxic control group - 11.8 kg. The average daily live weight gain per animal in the same groups was 456.7 g and 393.3 g, respectively. In the toxic control group, feed consumption was reduced by 7.4% compared to the group of animals receiving the main diet with mycotoxins with the addition of "Galluasorb". A decrease in the feed conversion ratio was also noted in the preventive group. Thus, the use of the complex adsorbent had a protective effect in the natural contamination of feed in the T-2 farm with toxin, aflatoxin, DON and zearalenone. The developed adsorbent also opens up prospects for the use of the natural mineral halloysite in combination with an antioxidant, hepatoprotector and organic sorbent in pig farming.

1 Introduction

Mycotoxins, toxic metabolites of microscopic fungi, are ubiquitous in feed and food raw materials [1-4]. However, to date, no effective means have been created to prevent combined mycotoxicoses.

The most common mycotoxins contaminating grain crops worldwide include metabolites of micromycetes of the genus *Fusarium* and *Aspergillus* – T-2 toxin, aflatoxin B₁, zearalenone and deoxynivalenol (DON) [5-8].

T-2 toxin belongs to type A trichothecenes, which have the highest toxicity of all trichothecenes [9] and cause a wide range of side effects in animals, such as growth

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retardation, immunodeficiency, gastrointestinal dysfunction, nervous system dysfunction, and reproductive capacity [10-14]. T-2 toxin stimulates lipid peroxidation, promoting the formation of free radicals [15, 16].

Aflatoxin B1 is the most dangerous and widespread mycotoxin, which is toxic to almost all animal species. Consumption of feed contaminated with aflatoxin can lead to significant liver damage and cause serious harm to pigs, which greatly limits the development of the pig industry. Oxidative stress is a key mechanism involved in the induction and pathogenesis of liver damage in hepatotoxicity caused by aflatoxin B1 [17-20].

Zearalenone is a non-steroidal mycotoxin with estrogenic properties that causes reproductive dysfunction, hepatotoxicity, hemotoxic, immunotoxic and genotoxic [21-24]. Zearalenone and its metabolites exhibit low acute toxicity, but their danger increases with prolonged intake. Among contaminants of grain products, deoxynivalenol (DON), also known as vomitoxin, is the most common trichothecene mycotoxin type B worldwide. Pigs are very sensitive to the toxic effects of DON and are often exposed to naturally contaminated feed [25], which also reduces specific antibody responses to the porcine reproductive and respiratory syndrome virus [26].

The difficulty in preventing mycotoxicosis lies in the frequent simultaneous presence of several mycotoxins in feed. Although the mycotoxin content may not exceed the MAC (maximum permissible concentration), together, reinforcing each other, they can cause a synergistic effect.

Organic and inorganic adsorbents are of great importance as methods of preventing mycotoxicosis [27-29]. The biological effect of adsorbents can be enhanced by creating complex preparations by including substances with antioxidant, hepatoprotective, immunomodulatory, etc. activity in their composition.

The purpose of this study was to evaluate the effectiveness of the method for preventing T-2, afla-, DON- and zearalenone toxicosis in pigs by including the complex adsorbent "Galluasorb" based on the natural mineral halloysite, methionine, milk thistle meal and plant glucans in feed naturally contaminated with four mycotoxins at once.

2 Materials and methods

The object of the study was the complex feed additive "Galluasorb" based on the natural mineral halloysite, plant β -glucans, methionine, milk thistle meal. We have previously proven the effectiveness of "Galluasorb" in mycotoxicosis in rats [30].

The safety of the complex mycotoxin adsorbent "Galluasorb" under farm conditions was assessed in an experiment on 20 two-month-old piglets divided into 2 groups for 30 days. The first group was the control (basic diet), the second group was the experiment ("Galluasorb", 2.5 kg per ton of feed).

The choice of the farm for determining the effectiveness of the complex mycotoxin adsorbent "Galluasorb" in mixed mycotoxicosis was determined by previously conducted mycotoxicological studies of feed using the enzyme immunoassay method. Analysis of the compound feed from the basic diet used for feeding young pigs with a live weight of 20-25 kg revealed the presence of T-2 toxin - 102.0 $\mu\text{g}/\text{kg}$, aflatoxin B1 - 55.3 $\mu\text{g}/\text{kg}$, zearalenone - 129.6 $\mu\text{g}/\text{kg}$, DON - 280 $\mu\text{g}/\text{kg}$.

The experimental design is presented in Table 1.

Table 1. Scheme of the experiment on piglets

Group of animals	Number of animals	Feeding characteristics
Toxic Control	10	Mycotoxin-containing food (toxic diet)
Experimental group	10	Toxic diet + "Galluasorb" (2.5 kg/ton of feed)

The parameters for evaluating the effectiveness of Galluasorb after 30 days of the experiment were: clinical status, blood test, weight gain, consumption and the ratio of feed consumed to live weight gain. At the end of the experiment, blood was collected from the mammary vein of piglets in sterile test tubes in compliance with aseptic and antiseptic rules (to determine hematological parameters, the blood was stabilized with EDTA-K3, for biochemical parameters, it was collected in Lab-Vac vacuum test tubes with a coagulation activator and gel).

Hematological studies were performed on the Mythic 18 Vet analyzer (OrpheeGeneva, Switzerland).

Determination of biochemical parameters was performed on the ARD-200 analyzer using special Chronolab reagent kits. During the study, the biochemical analyzer determined the content of glucose, total protein, aminotransferases (aspartate aminotransferase (AST), alanine aminotransferase (ALT)), alkaline phosphatase.

Statistical processing of the obtained data was carried out in the software environments MS Excel and Statistica 6.0.

3 Results and discussion

During the entire observation period after the inclusion of the complex adsorbent in the feed, no signs of intoxication were observed in pigs. The drug did not have a negative effect on behavioral reactions, food excitability, or the general condition of animals. During the experiment, no deaths of animals were observed, either in the experimental or in the control groups.

Table 2 presents the indicators of live weight gain, morpho-biochemical indicators of pigs with repeated administration of the studied complex mycotoxin adsorbent.

Table 2. Evaluation of the safety of the complex mycotoxin adsorbent "Galluasorb" in experiments on pigs (n=10)

Indicator	Group	
	1	2
Live weight on the day of the experiment, kg	24,0±1,22	24,1±1,71
Live weight at the end of the experiment, kg	37,2±1,37	38,5±2,92
Absolute gain in live weight, kg	13,2±0,85	14,4±0,85
Average daily gain in live weight, g	440,0±1,31	480,0±2,55
Relative increase in live weight, %	55,0±0,89	59,7±1,15
Feed consumption, kg	44,9±0,47	45,86±0,96
Feed Conversion Ratio	3,40±0,15	3,19±0,60
Erythrocyte, x10 ¹² /l	5,5±0,21	5,6±0,42
Leukocytes, x10 ⁹ /l	16,0±0,93	15,5±1,61
Hemoglobin, g/l	107,1±1,17	110,8±2,92
Glucose, mmol/l	4,35±0,15	4,37±0,21

Total protein, g/l	60,5±1,23	61,7±2,55
AST, U/l	47,1±1,36	48,9±1,55
ALT, U/l	34,2±1,06	35,7±1,14
ALP, U/l	39,1±0,56	36,8±1,27

Long-term intake of Galluasorb with feed (30 days) does not have a negative impact on live weight gain. A study of the morphological and biochemical parameters of the blood of pigs that received Galluasorb for 30 days did not reveal statistically significant differences in the studied parameters relative to the biological control group.

Over the course of 30 days of observation after the cessation of the introduction of the complex adsorbent into the feed, no changes in the general condition of the experimental animals were found.

Research has shown that during one month of using "Galluasorb" with feed naturally contaminated with four mycotoxins at once (T-2 toxin, aflatoxin B1, DON and zearalenone), no signs of digestive upset were observed in piglets. The toxic effect of mycotoxins (suppression, decreased food excitability, digestive disorders, low productivity) was observed in a group of animals that received only toxic feed.

The most important zootechnical parameter for assessing the effectiveness of a complex adsorbent is its effect on the growth and development of animals. Table 3 shows the results of studies to assess the dynamics of live weight gain in pigs.

Table 3. Main zootechnical indicators of piglets against the background of the use of "Galluasorb" (n=10)

Indicator	Group of animals	
	1	2
Live weight on the day of the experiment, kg	24,3±1,53	23,9±1,61
Live weight at the end of the experiment, kg	36,1±1,89	37,6±1,87
Absolute gain in live weight, kg	11,8±0,98	13,7±0,57*
Average daily gain in live weight, g	393,3±2,97	456,7±2,02*
Relative increase in live weight, %	48,6±1,88	57,3±1,21*
Feed consumption, kg	41,9±0,80	45,0±0,87
Feed Conversion Ratio	3,55±0,68	3,3±0,61*

* p<0.05, when compared with toxic control values

The live weight gain rate of animals depends on the quality of the feed used and the conditions of keeping and growing animals. On the 30th day of the experiment, the absolute live weight gain of piglets receiving the main diet with mycotoxins with the addition of "Galluasorb" was 13.7 kg, while in piglets of the toxic control group it was 11.8 kg, which is 16.1% lower ($p < 0.05$). The average daily live weight gain per animal in these same groups was 456.7 g and 393.3 g. Obviously, mycotoxins in the diet served as limiting factors for the availability of nutrients, which can be estimated by the volume of feed consumption by animals.

A sudden decrease in feed consumption by animals was recorded. Thus, in the toxic control group, a decrease in feed consumption by 7.4 % was observed compared to the group of animals receiving the basic diet with mycotoxins with the addition of Galluasorb. A decrease in the feed conversion ratio in the prevented group was also noted, calculated as the ratio of the amount of feed consumed to the live weight gain. In the toxic control group, on

the contrary, an increase in this ratio by 7.0 % ($p < 0.05$) was observed in relation to the group of animals receiving feed contaminated with mycotoxins with the addition of a complex adsorbent. This value of feed conversion is determined by the degree of assimilation and activity of digestion of nutrients from feed by animals. There is no doubt that feed conversion by pigs is a key indicator and the main factor for making many production decisions. The lower the feed conversion, the more efficient the production. Thus, the use of the complex preparation had a protective effect in the case of natural contamination of feed on the farm with T-2 toxin, aflatoxin, DON and zearalenone, which was demonstrated by the example of live weight gain, consumption and feed conversion.

The obtained results of the study of morpho-biochemical blood parameters are presented in Table 4.

Table 4. Morpho-biochemical indices of piglets with T-2, afla-, DON and zearalenone toxicosis against the background of the use of a complex adsorbent (n=10)

Indicator	Group of animals	
	1	2
Erythrocyte, $\times 10^{12}/l$	4,8 \pm 0,2	5,7 \pm 0,1*
Leukocytes, $\times 10^9/l$	13,3 \pm 1,17	15,3 \pm 1,7*
Hemoglobin, g/l	92,8 \pm 2,3	110 \pm 3,3*
Glucose, mmol/l	3,7 \pm 0,3	4,4 \pm 0,5*
Total protein, g/l	55,9 \pm 2,7	61,6 \pm 4,2
AST, U/l	74,9 \pm 6,1	34,7 \pm 2,8**
ALT, U/l	137,2 \pm 8,2	32,5 \pm 3,11**
ALP, U/l	145,9 \pm 10,8	117,7 \pm 12,2*

* $p < 0.05$, ** $p < 0.01$, when compared with toxic control values

Morphological and biochemical blood tests in the toxic control group revealed a disturbance in the body's oxidation-reduction balance. The effect on hematological indices was expressed in a decrease in the number of erythrocytes by 15.8 % ($p < 0.05$), hemoglobin by 15.6 % ($p < 0.05$), and leukocytes by 13.1 % ($p < 0.05$) compared to the prophylaxis group.

A decrease in the level of total protein and glucose by 9.3 and 15.9% ($p < 0.05$) was noted in the toxic control group compared to the second group, indicating a metabolic disorder and increased enzymatic activity. In our study, the level of transaminases (AST and ALT), catalyzing processes associated with protein metabolism, was characterized by a reliable increase in activity in the toxic control group by 2.2 and 4.2 times, respectively, relative to the group prevented by Galluasorb. Thus, the addition of a complex adsorbent at the rate of 2.5 kg / ton of feed contaminated with mycotoxins, favorably affected the hematological and biochemical blood parameters of the experimental animals. Changes in the studied parameters were less pronounced.

4 Conclusions

Mycotoxins are found not only in feed and feed raw materials, but also in livestock products, which leads to further severe spread of contamination along the food chain. The complexity of preventive and therapeutic measures for mycotoxicosis is associated with the high chemical stability of mycotoxins, which complicates their inactivation during the production and processing of feed. Therefore, the development of effective environmentally friendly preventive measures based on natural raw materials is of great practical importance for animal husbandry in general and pig farming in particular. Thus, "Galluasorb", having a

multifunctional effect, neutralizes mycotoxins when it is impossible to replace toxic feed for pigs with good-quality feed, which leads to the normalization of the general condition, morpho-biochemical parameters of the blood, an increase in weight gain and feed consumption against the background of a decrease in its conversion relative to the toxic control group. This indicates that the developed adsorbent opens up prospects for the use of the natural mineral halloysite in combination with an antioxidant, hepatoprotector and organic sorbent in pig breeding.

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