Combined effects of deltamethrin and T-2 toxin on animals during the use of bentonite

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Abstract. This study investigated the combined effects of deltamethrin and T-2 toxin on animals, utilizing bentonite as a prophylactic agent. The research was conducted on white rats, which were orally administered the toxins for 20 consecutive days. Subsequently, clinical, hematological, and biochemical parameters were examined to assess the impact of the toxins on the animals. Based on research results, it has been established that the combined effect of deltamethrin and T-2 toxin with repeated administration is characterized by more severe clinical, hematological and biochemical changes than with separate exposure to toxicants. Accompanied by a decrease in the number of leukocytes, erythrocytes and hemoglobin, a decrease in total protein, glucose and cholinesterase activity. Adding bentonite to the feed as a prophylactic agent at a dose of 2% of the diet has a preventive effect in case of combined poisoning with deltamethrin and T-2 toxin, and helps to normalize the clinical, hematological and biochemical parameters of animals.

1 Introduction

Pesticides are diverse chemical or biological substances that are used to control, repel, or destroy pests such as insects, weeds, and plant diseases. They are commonly employed in agriculture, forestry, and household settings to protect crops, manage pests, and ensure plant health. It's important to use pesticides judiciously, as their misuse or overuse can have detrimental effects on the environment and human health. Regulatory bodies play a crucial role in overseeing the use of pesticides and implementing measures to minimize their negative impact on the environment and human health. Adhering to instructions for the safe application and storage of pesticides, as well as seeking out safer alternatives such as

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biological or eco-friendly pest control methods, can mitigate potential risks associated with pesticide use [1, 2].

Pesticides can pose considerable risks to animals, as they may come into contact with these chemicals through contaminated food, water sources, or direct exposure to treated areas. Potential dangers for animals include acute or chronic health effects, such as gastrointestinal disturbances, neurological issues, respiratory problems, skin irritation, and reproductive complications. In severe cases, pesticide exposure can lead to poisoning in animals. Livestock, poultry, and household pets are particularly susceptible to pesticide exposure, especially when they encounter treated crops, water sources contaminated with pesticides, or residues in their feed. Implementing careful practices during pesticide application, proper storage, and disposal to prevent direct animal exposure is crucial in safeguarding animal health. Furthermore, seeking veterinary guidance if pesticide exposure is suspected can help in addressing potential health risks for animals. Regular monitoring for signs of pesticide-related health concerns in animals is also important for early identification and intervention [3, 4].

Deltamethrin is a synthetic insecticide belonging to the pyrethroid group, and it is widely used to control a variety of pests in agricultural, public health, and residential settings. It effectively targets and controls numerous insect pests, including mosquitoes, flies, ants, and fleas. Deltamethrin acts on the nervous system of insects, causing paralysis and ultimately leading to their demise. In agriculture, deltamethrin is utilized to protect crops from damage caused by insect pests. In public health, it is employed for mosquito control to reduce the spread of vector-borne diseases. Additionally, in residential settings, deltamethrin may be used to manage pests such as ants, cockroaches, and bed bugs. As with any pesticide, it's essential to handle deltamethrin with care and be mindful of its potential impact on non-target organisms and the environment, while ensuring compliance with regulations governing its use [5, 6].

Mycotoxins are harmful substances produced by certain molds found in food and feed, and they can pose serious health risks to humans and animals. Common mycotoxins include aflatoxins, ochratoxin A, T-2 toxin, and deoxynivalenol, among others. Mycotoxins pose significant dangers to animals when they are ingested through contaminated feed or forage. The potential health impacts on animals can include reduced feed intake, poor growth performance, immune system suppression, reproductive issues, and a higher susceptibility to diseases and infections. Mycotoxin exposure can also lead to organ damage, particularly affecting the liver and kidneys. To address these risks, it is important for farmers and animal nutritionists to carefully monitor and manage mycotoxin contamination in animal feed. Implementing measures such as proper storage of feed ingredients, regular testing for mycotoxin levels, and utilizing mycotoxin-binding agents in feed formulations can help mitigate the risks associated with mycotoxin exposure in animals [7, 8].

T-2 toxin is a type A trichothecene mycotoxin produced by certain species of fungi, including Fusarium. This toxin can contaminate various agricultural products such as grains, corn, and wheat, and poses a risk to both human and animal health. T-2 toxin is known for its toxic effects, which can include damage to the skin, digestive system, and immune function. Exposure to T-2 toxin can cause a range of health issues such as nausea, vomiting, diarrhea, skin irritation, and potential long-term effects on organ function. In animals, exposure to T-2 toxin can lead to reduced feed intake, weight loss, and negative impacts on overall health and productivity. To mitigate the risks associated with T-2 toxin, it's important to implement measures such as proper storage and monitoring of grains and feedstuffs, as well as following good agricultural and manufacturing practices [9, 10].

Currently, due to the increasing anthropogenic impact on the environment, toxicants of both natural and anthropogenic origin are increasingly found in feed. The effect of the combined action of xenobiotics depends on the route of entry into the body, dose levels and

their ratios, toxicokinetics, biotransformation and the mechanism of action of the individual components of the combination. Of greatest interest are the results of studying the combined effect of pollutants at a threshold level and the level of actual daily intake under real environmental pollution. At the same time, it is advisable to evaluate the effect of complex combinations of chemical substances using indicators that integrally reflect changes in the functional state of the body and the severity of the formed pathological process [11, 12].

Recently, the enterosorption method has been very often used to prevent animal poisoning. The use of sorbents in the treatment of animals involves the administration of substances that can bind to and remove toxins from the gastrointestinal tract. This can be helpful in cases of poisoning or toxin ingestion in animals. Commonly used sorbents in veterinary medicine include activated charcoal, kaolin and bentonite. Bentonite is a type of clay that is commonly used as a gastrointestinal sorbent in the treatment of animals. When animals are exposed to certain toxins or poisons, bentonite can be administered orally to help bind to these toxins in the gastrointestinal tract, preventing their absorption into the bloodstream. Bentonite is known for its ability to adsorb and bind to various toxins, including certain mycotoxins and harmful substances present in the digestive system. By binding to these toxins, bentonite can help reduce their potential harmful effects on the animal's body and aid in their elimination through the feces. However, it's important to emphasize that the use of bentonite or any other treatment should be carried out under the guidance of a veterinarian. The specific dosage, administration method, and duration of treatment with bentonite should be determined by a qualified veterinary professional based on the individual animal's condition and the type of toxin involved [13, 14].

The purpose of the research was to study the combined effects of deltamethrin and T-2 toxin on animals against the background of the use of bentonite as a prophylactic agent.

2 Materials and methods

The studies were carried out on white rats weighing 150-180 g. For this purpose, 5 groups of animals of 12 animals each were formed. The first group served as a control and received solvents in a similar volume, the second received deltamethrin at a dose of 1/10 LD_{50}, the third group received T-2 toxin at a dose of 1/10 LD_{50}, the fourth group received both toxicants at the same time, the animals of the fifth group received both toxicants with the addition of bentonite is added to feed as a prophylactic agent at a dose of 2% of the diet. The animals were administered toxins orally for 20 days, followed by the study of clinical, hematological and biochemical parameters. Determination of hematological parameters was carried out on a Mythic 18 analyzer, biochemical parameters on a STATFAX 3300. Student's t-test was used to determine statistically significant differences.

3 Results and discussion

Clinical signs of poisoning began to appear at an earlier time in the group of rats that received both toxicants together without bentonite, and were characterized by depression, decreased appetite, ruffled fur, unsteady gait, and diarrhea. In groups that received toxins separately, the clinical picture of intoxication appeared at a later date and was less pronounced. In the group of rats that received bentonite along with toxins, the clinical picture of poisoning was also less pronounced.

During the experiment, the weight gain in animals receiving only deltamethrin was 15.9% higher than in the control group. In rats receiving only T-2 toxin, body weight gain was 16.9% lower than control. With combined exposure to toxicants, the lag in the growth of live

weight occurred more significantly and amounted to 23.6%. In rats that received bentonite along with toxins, body weight was 8.3% lower than the control.

The results of studies of hematological parameters of rats under separate and combined exposure to deltamethrin and T-2 toxin are presented in Table 1.

Table 1. Hematological parameters of rats.

Research time, day	Group	Indicator		
		erythrocytes, $x10^{12}$/l	leukocytes, $x10^{9}$/l	hemoglobin, g/l
10	1	7.76±0.70	8.18±0.32	128.5±6.9
	2	6.47±0.22	8.75±0.41	116.4±1.8
	3	6.62±0.28	7.20±0.31	112.7±2.8
	4	6.47±0.39	7.16±0.25	110.9±3.9
	5	6.67±0.35	7.81±0.36	114.5±2.9
20	1	7.58±0.58	7.81±0.35	135.7±3.4
	2	5.78±0.29*	9.07±0.19*	98.6±2.9*
	3	5.56±0.17*	5.43±0.17*	96.4±5.7*
	4	5.47±0.11*	5.75±0.22*	90.1±2.5*
	5	6.43±0.24	6.76±0.32	108.4±3.2*

* - $p < 0.05$

Table 1 shows that in rats receiving only deltamethrin, the decrease in the number of erythrocytes compared to the control on days 10 and 20 was 13.1 and 23.7%, while those receiving T-2 toxin were 14.7 and 26.6% accordingly, with the combined administration of these toxicants, the number of erythrocytes decreased at the same time by 16.6 and 27.8%, respectively, and when bentonite was added to the feed, it decreased by 14.0 and 15.2%, respectively.

The number of leukocytes in the second group of rats increased by 7.0% by 10 days, by 16.1% by 20 days, in the third group on days 10 and 20 the leukocyte content decreased by 12.0 and 30.5%, in the fourth group in the same period the decrease was 12.5 and 26.3%, in the fifth group - by 4.5 and 13.4%, respectively.

The hemoglobin content in the second group on days 10 and 20 decreased compared to the control by 9.4 and 27.3%, in the third group - by 12.3 and 29.0%, in the fourth group the decrease in hemoglobin at the same time was 13.7 and 33.6%, in the fifth group – by 10.9 and 20.1%, respectively.

The results of studies of biochemical parameters of the blood of rats under separate and combined exposure to deltamethrin and T-2 toxin are presented in Table 2.

Table 2. Biochemical parameters of rats.

Research time, day	Group	Indicator		
		cholinesterase, mM/(h*l)	glucose, mM/l	total protein, g/l
10	1	0.82±0.04	5.21±0.20	68.0±4.1
	2	0.71±0.03	4.60±0.18*	68.3±2.2
	3	0.79±0.02	4.81±0.17	58.3±2.5
	4	0.76±0.04	4.60±0.15*	62.8±1.1
	5	0.79±0.03	4.71±0.17	67.4±2.5
20	1	0.78±0.03	5.00±0.20	67.4±3.2
	2	0.65±0.03*	3.56±0.22*	59.6±2.2
	3	0.68±0.05	3.94±0.10*	55.0±3.7*
	4	0.62±0.02*	3.55±0.22*	54.5±1.7*
	5	0.70±0.03	3.82±0.14*	58.3±2.1

* - $p < 0.05$

According to Table 2, during the experiment, a decrease in cholinesterase activity was observed in all experimental groups. In the group of rats receiving deltamethrin, cholinesterase decreased by 10 days by 13.4%, by 20 days by 16.7%, in the group receiving T-2 toxin by 10 days by 3.7%, by 20 days by 12.2%. With the combined intake of deltamethrin and T-2 toxin, the level of cholinesterase activity decreased by 7.3% by 10 days, by 20.7% by 20 days, and when bentonite was added to the feed - by 3.7 and 10.3%, respectively.

The decrease in glucose content in the blood of animals of the second group, compared with the control, on days 10 and 20 was 11.5 and 28.8%, respectively. In the third group, the decrease by 10 and 20 days was 7.7 and 21.2%, in the fourth – 11.5 and 29.0%, in the fifth – 9.6 and 23.6%, respectively. The protein content in the second group on day 10 did not differ from the control, on day 20 it decreased compared to the control by 11.6%, in the third group it decreased by 14.3 and 18.4%, in the fourth group - by 7.6 and 19.1%; in the fifth group, the decrease in protein at the same time was 0.9 and 13.5%, respectively.

4 Conclusion

Combined exposure to deltamethrin and T-2 toxin with repeated administration is characterized by more severe clinical, hematological and biochemical changes than with separate exposure to toxicants. Accompanied by a decrease in the number of leukocytes, erythrocytes and hemoglobin, a decrease in total protein, glucose and cholinesterase activity.

Adding bentonite to the feed as a prophylactic agent at a dose of 2% of the diet has a preventive effect in case of combined poisoning with deltamethrin and T-2 toxin, and helps to normalize the clinical, hematological and biochemical parameters of animals.

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