



## RESEARCH ARTICLE

# Veterinary medicine based on montmorillonite clay from Western Kazakhstan for the treatment and prevention of infectious diseases in farm animals

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### Abstract

The relevance of this research is associated with the great potential of using montmorillonite clay for the treatment and prevention of infectious diseases of important farm animals and the lack of knowledge of these issues in modern literature. The paper was aimed at studying the toxicity, therapeutic and prophylactic efficacy of a veterinary drug developed based on montmorillonite clay of Western Kazakhstan for bovine gastroenteritis. The paper involved clinical, laboratory and pathoanatomical research methods. The obtained data were analysed using statistical methods. Oral administration of the developed veterinary drug did not have a significant effect on the parameters of the biochemical blood test of rats ( $p > 0.05$ ) and the morphology of their internal organs after 2 weeks. The developed drug does not have toxicity; it can be attributed to the class of low-hazard substances. With a high degree of probability ( $p < 0.05$ ), it can be argued that the veterinary drug improves the results of the standard treatment regimen for acute gastroenteritis in Kazakh whitehead cattle by 15%-30%. With a probability of 95%, it can be argued that the addition of the developed veterinary drug to the diet for 30 days led to a decrease in the incidence of gastroenteritis by 2.3 - 3.5 times among cattle. In addition, metabolic processes in the body of animals significantly ( $p < 0.05$ ) improved in the three experimental groups, compared with the control group, in which cattle received a standard diet. Pathological and anatomical study and histological examination of organs and tissues of cows did not reveal significant differences between animals from the experimental and control groups. The results obtained may be useful in the development of effective methods for the treatment and prevention of gastroenteritis in cattle.

**Keywords:** cattle; gastroenteritis; productivity; diet; metabolic processes.

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## 1. Introduction

Recently, clays with a high content of montmorillonite have been effectively used in various industries, for example, for the purification of natural waters (Maliuk et al., 2024). Adryshev et al. (2008) showed that such clays can improve the quality of water in the East Kazakhstan region by 70% and significantly reduce the content of harmful substances in it. This is because montmorillonite is highly absorbent and can bind and retain harmful substances. In this regard, the use of montmorillonite clay for veterinary purposes is of particular interest. Ghosh & Chakraborty (2023) studied that montmorillonite clay successfully absorbs pathogens. Such clay has a good potential for treating infectious animal diseases that cause serious damage to agriculture.

Cattle breeding in Kazakhstan, according to Umbataliyev (2013), is one of the major livestock industries that constantly faces the problems of poor infrastructure, unbalanced feed resources and frequent outbreaks of infectious diseases. In this regard, the development of new effective methods of treatment is of paramount importance for providing the population with quality food. The modern literature also provides data on the effectiveness of montmorillonite not only in the treatment, but also in the prevention of diseases caused by pathogenic bacteria and fungi. I. Bueno et al. (2023) showed the effectiveness of veterinary preparations based on montmorillonite for the prevention of infectious diseases in broilers. Vasilyanova (2016) noted a 2.7-fold decrease in the number of diseased piglets

compared to the control group, in which the animal's received food without the addition of montmorillonite clay. Thus, it was shown that montmorillonite clay played a significant role in disease prevention.

To develop balanced diets for cattle, it is necessary to use various supplements containing the minerals necessary for the successful functioning of animals. Natural minerals can be used as a source of such components (Sharaby et al., 2024). According to Adamis et al. (2005) the addition of this montmorillonite clay to the feed leads to an improvement in such indicators as calcium (by 27%), iron (by 47%), copper (by 12.5%), zinc (by 26%). Despite the study by Gouda et al. (2019) that the addition of montmorillonite has a positive effect on milk yield and fat content, to date, little attention has been paid to the use of montmorillonite clay to improve the productivity of cattle, as well as to treat and prevent diseases in this group of animals.

In addition, the question of the toxicity of montmorillonite clay remains unresolved. Recent studies by Guo et al. (2023) indicate the toxicity of montmorillonite. On the other hand, Bezzekhami et al. (2023) believe that montmorillonite clay is safe and when it is taken, negative changes in the morphofunctional state of a living organism are impossible. Therefore, this issue requires further research. It is also interesting to study the montmorillonite clay of Kazakhstan. The addition of clay with a high content of montmorillonite from the Taganskoe deposit to the feed made it possible to increase the profitability of the pig rearing process by 11% (Bellaj et al., 2024).

The purpose of this paper is to study the toxicity, therapeutic and prophylactic efficacy of the drug based on montmorillonite clay of Western Kazakhstan in bovine gastroenteritis.

## 2. Methodology

Research was conducted based on SEC "Shamshyrak" in Oral (Republic of Kazakhstan, West Kazakhstan Region). Sampling of montmorillonite clay was carried out from the Taganskoe deposit of Western Kazakhstan. The chemical composition of the clay was analysed using standard physical-chemical methods, as well as X-ray phase analysis. Based on the montmorillonite clay (60%), a veterinary preparation was developed, which also included a siliceous rock – gaze (20%) and chalk (20%). All these mineral components were extracted from a deposit in Western Kazakhstan.

Wistar rats were used to evaluate toxicity of the developed preparation. The research involved 20 rats, two groups were formed: experimental (5 males

and 5 females) and control (5 males and 5 females). After adaptation to the new conditions, 5 g of the developed veterinary drug per 1 kg of animal weight was administered through the oral gastric tube. During the first 3 hours, continuous observation of the animals' behavior was carried out. Then their vital signs were recorded every day. On the 14th day, blood analysis was performed, and the animals were removed from the experiment by applying carbon dioxide. After that, an autopsy was performed to reveal abnormalities in the structure of internal organs.

Three experimental groups (EG-1, EG-2, EG-3) and one control group (CG) of cattle of Kazakh white-head breed with acute gastroenteritis were formed to determine the therapeutic effectiveness of the veterinary drug. The groups were formed according to the principle of analogy. The standard scheme of acute gastroenteritis treatment was applied in all experimental and control groups. The animals were prescribed a starvation diet for the first day. They consumed only water and sodium chloride solution with glucose. On the following days of the experiment, the experimental animals received food in small portions. They were also given Streptocid, Furacilin and Floridox. For 14 days, cattle from 3 experimental groups, in addition to the standard treatment regimen, received 400 mg of the developed veterinary drug per 1 kg of body weight together with feed. Also, for 2 weeks, daily clinical observations were carried out, as well as at the beginning and end of the experiment, microbiological analyses of faeces of animals from the experimental and control groups were carried out.

Three experimental groups (EG-1, EG-2, EG-3) and one control group (CG) of Kazakh whitehead cattle were formed to study the preventive effectiveness of the veterinary drug based on montmorillonite clay according to the principles of analogues. For 30 days, the animals of the experimental groups had their rations enriched with the developed veterinary drug at a dose of 400 mg per 1 kg of body weight. Cattle from the control group received only fodder. For one month, the animals were clinically observed and the number of diseased animals with gastroenteritis was recorded. Microbiological analyses by standard methods of cattle faeces were performed at the beginning and at the end of research (Rapp et al., 2023). On day 30, blood tests and pathological anatomical examination of the EG and CG cows were performed. Autopsy and histological examination of organs and tissues were performed using conventional methods.

In all experiments, blood analysis was performed by standard methods on a Coulter AcT 5diff Cap Pierce

(CP) analyser (Menta et al., 2024). One-factor analysis of variance was applied for static data analysis. The results were processed using the standard software package "PASW Statistics 17". It should also be noted that in the present study, the null hypothesis at  $p < 0.05$  was rejected, thus allowing no more than 5% possibility of error.

### 3. Results and discussion

Kazakhstan has significant reserves of clays containing montmorillonite, a mineral with high absorption capacity. The crystal lattice of this mineral is not static, represented by a layer of  $Al_2O_3$  located between layers of silica  $SiO_2$  (Vasilyanova, 2016). There are oxygen atoms on the surface of the elementary structures of montmorillonite, which affects the mobility of the crystal lattice of the mineral, which can easily bind and hold water or other polar liquids, as well as other negatively and positively charged particles (Figure 1).

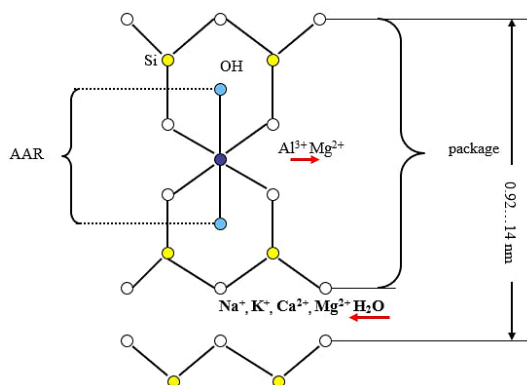


Figure 1. Schematic of the crystal lattice of montmorillonite. Created by the authors based on Nuruzzaman et al. (2016).

The distance between the layers representing the montmorillonite crystal lattice ranges from 0.92 nm (in the absence of water or other polar molecules) to 14 nm. Such an increase contributes to the swelling of the clay and causes its high absorption. Due to such abilities of the mineral, it has several valuable properties: it removes harmful substances from the body, positively affects the indicators of animal productivity, and normalizes metabolic processes in the body. The study of the practical application of montmorillonite clay of Western Kazakhstan is of great interest, as deposits from this region stand out for their high clay quality. The results of the chemical analysis of clay are presented in Table 1.

Table 1  
Chemical composition of montmorillonite clay of Western Kazakhstan: the content of oxides

SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	CaO	MgO	Fe <sub>2</sub> O <sub>3</sub>	SO <sub>3</sub>	Na <sub>2</sub> O
61.51	17.06	2.27	3.21	6.36	1.27	3.57

To assess the toxicity, 5 g of a veterinary preparation based on montmorillonite clay per 1 kg of body weight was administered to the rats once. In the first 3 hours after the drug administration, no abnormalities in animal behavior were detected. The biological effects that appeared at the end of 14 days after administration of the developed preparation are shown in Table 2.

No abnormal reactions were observed during this time: the rats were active, had a healthy appearance, and possessed good immunity. After 14 days, blood samples were taken from the experimental animals and an autopsy was performed, which revealed no deviations from the norm in the morphology of internal organs. Thus, blood analysis did not confirm a statistically reliable effect of the veterinary preparation based on montmorillonite clay on the blood parameters in the rats from the experimental and control groups. The developed veterinary drug has no toxicity; it can be classified as a low-hazardous substance. Experimental work to determine the therapeutic effectiveness of the veterinary drug showed a high degree of its effectiveness in the treatment of acute gastroenteritis (Figure 2).

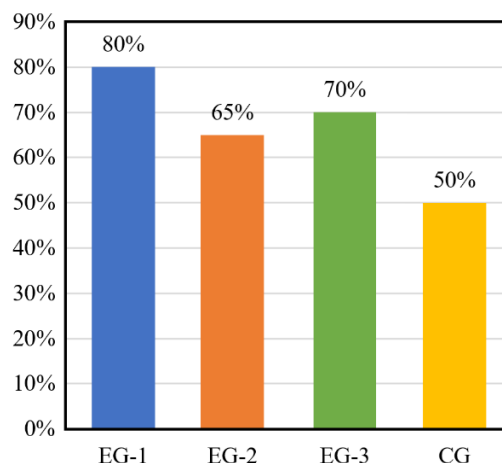
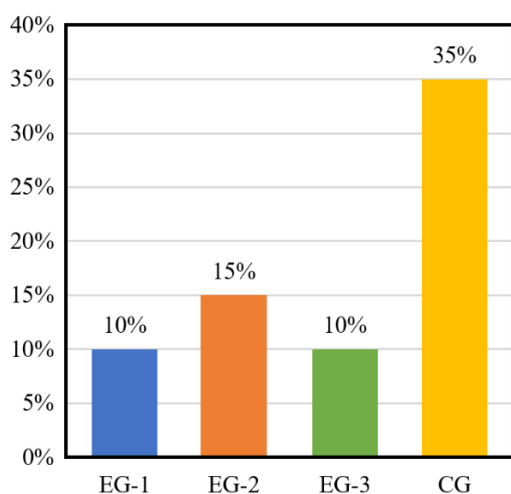


Figure 2. The results of using the veterinary drug based on montmorillonite clay in the treatment of acute gastroenteritis.

As can be seen from Figure 2, the combination of the developed veterinary preparation with the standard scheme of treatment allowed increasing the percentage of recovered animals by 30%, 15% and 20% for EG-1, EG-2 and EG-3, respectively, in comparison with the control group where the animals were subjected to the standard scheme of treatment. Using a single-factor analysis of variance, statistically significant differences were found between the three experimental and control groups.  $F_{emp} = 8.41$ , for significance level  $p = 0.05$ ,  $F_{cr}$  was found from the Fisher-Snedecor distribution table:

$f_{cr} = 1.96$ . Since the empirical value of the criterion is greater than the critical one, it means that the differences are statistically significant. Thus, it can be stated with a high degree of probability that the veterinary drug based on montmorillonite clay contributed to an increase in the percentage of cured animals. In addition, treatment with the developed preparation significantly affected the microflora of faeces (Dushayeva et al., 2013). Thus, the concentration of microorganisms in the faeces of animals from the three experimental groups significantly decreased (by 47% - 67%) compared with the control group. The experiment to study the preventive effectiveness of the preparation based on montmorillonite clay revealed that this preparation has a high potential for the prevention of various diseases (Figure 3).



**Figure 3.** Results of applying a veterinary preparation based on montmorillonite clay for the prevention of gastroenteritis.

Figure 3 shows that within 30 days, only 10-15% of the animals in the three experimental groups fell ill, while for the control group this figure was 35%. The difference in these rates was reliable at a high level

of significance ( $F_{emp} = 7.11$ ;  $p < 0.05$ ). Observations showed that throughout the experiment, physical properties of faeces of experimental animals from EG-1, EG-2, EG-3 did not differ from those of animals from the control group. However, the animals that received the preparation based on montmorillonite together with the food had the presence of protein in the urine. However, this amount was minimal. As is known, blood plays an important role in maintaining homeostasis in the body. It also performs a transport function, delivering the necessary components for the successful life of the organism. At the end of the experiment, blood biochemical analysis was conducted for the three experimental groups and control group. Its results are presented in Table 3.

Protein is an integral component of all living organisms. In this regard, such an indicator as the total amount of protein in the blood serum plays an important role during the diagnosis and prediction of various conditions (Biyashev et al., 2016). For example, if the amount of protein in the body is insufficient, productivity may decrease, and growth and development of the organism may be delayed. Table 3 shows that in all the experimental groups and one control group, such an important indicator as total protein in the blood serum was within normal limits. However, the protein concentration of the experimental animals that received the veterinary drug together with the feed, the protein concentration was higher by 10%, 9.8% and 9.3% (EG-1, EG-2, EG-3, respectively) compared to the control. Single-factor analysis of variance revealed statistically significant differences in the value of this index between the experimental and control groups ( $F_{emp} = 6.09$ ;  $p < 0.05$ ). Also, the concentration of glucose in the blood serum of the experimental groups significantly increased by 10.1-12% ( $F_{emp} = 5.49$ ;  $p < 0.05$ ). Phosphorus values also significantly improved by 8.1%, 6.8%, and 7.4% for EG-1, EG-2, and EG-3, respectively ( $F_{emp} = 8.09$ ;  $p < 0.05$ ).

**Table 2**

Results of the body condition of rats after 14 days after oral administration of the veterinary drug based on montmorillonite clay

	Experimental group	Control group	Statistical significance of differences (ANOVA)
Pathological disorders of internal organs after 14 days of the experiment	None	None	-
Erythrocytes, $10^{12} l^{-1}$	$8.43 \pm 0.9$	$8.87 \pm 0.8$	$p > 0.05$
Haemoglobin, g/l	$152 \pm 2$	$155 \pm 2.72$	$p > 0.05$
Haematocrit, %	$44.3 \pm 0.9$	$45.7 \pm 0.87$	$p > 0.05$
White blood cells, $10^9 l^{-1}$	$8.43 \pm 0.7$	$9.02 \pm 0.54$	$p > 0.05$
Neutrophils, %	$32.33 \pm 1.03$	$36.43 \pm 1.23$	$p > 0.05$
Basophils, %	$1.93 \pm 0.34$	$2.03 \pm 0.44$	$p > 0.05$
Lymphocytes, %	$0.27 \pm 0.01$	$0.32 \pm 0.01$	$p > 0.05$
Monocytes, %	$5.8 \pm 0.4$	$6.27 \pm 0.51$	$p > 0.05$
Platelets, $10^9 l^{-1}$	$718 \pm 12$	$724 \pm 10$	$p > 0.05$

Note: at  $p > 0.05$ , the differences are statistically insignificant.

Serum calcium concentrations increased by 12%, 11%, and 11.5% for EG-1, EG-2, and EG-3, respectively, compared with the control. The difference in values was also reliable at a high level of significance ( $F_{emp} = 8.09$ ;  $p < 0.05$ ). Thus, the veterinary preparation based on montmorillonite of Western Kazakhstan contributed to the improvement of mineral metabolism in cattle (Zhakupova et al., 2017). It also had a positive effect on the concentration of total protein and glucose in blood serum. It can be assumed that in addition to the preventive effectiveness, the developed preparation improved the metabolic processes in cattle (Table 4).

Thus, pathological anatomical examination revealed no significant differences in the morphology of internal organs between the animals of the experimental and control groups. Both animals were healthy, except that the cow from the control group had slightly enlarged spleen, liver and kidneys. Histological examination of the organs and tissues of the cows showed no pathological changes in the state of internal organs of both the experimental animals from the experimental groups and the cows from the control group. No pathological changes

were found in the tissues of the spleen, liver and kidneys in all the studied groups. The developed veterinary drug based on montmorillonite clay is a highly effective remedy for prevention and treatment of gastroenteritis in cattle.

Montmorillonite clay is successfully used in various industries, such as light industry, agriculture, and medicine. Such clay is widely used in the production of feed for important crops, as well as in the manufacture of veterinary drugs, because the addition of montmorillonite can have a positive effect on animal productivity indicators (Saribayeva et al., 2015). For example, cows have improved milk yield and its fat content (Jiang et al., 2018; Gouda et al., 2019). The veterinary preparation presented in this paper was developed based on montmorillonite clay from the deposits of Western Kazakhstan. Montmorillonite clay from most of the deposits in Kazakhstan is not inferior in its key characteristics to reference clays from Europe and the United States (Vasilyanova, 2016). The chemical analysis showed that the clay of Western Kazakhstan mainly consists of two oxides: SiO<sub>2</sub> (61.51%) and Al<sub>2</sub>O<sub>3</sub> (17.06%).

**Table 3**

Blood test results after 30 days of administration of a veterinary drug to prevent gastroenteritis

Indicators	EG-1	EG-2	EG-3	CG
Erythrocytes, 10 <sup>12</sup> /l	6.7±0.15	6.52±0.13	6.8±0.04	5.92±0.2
White blood cells, 10 <sup>9</sup> /l	6.5±0.27	6.7±0.46	6.9±0.23	7.3±0.4
Hemoglobin, g/l	113.5±1.08	110.2±1.28	104.5±1.38	98.52±1.23
Total protein, g/l	80.52±0.91	80.37±1.03	80.01±0.73	73.2±0.81*
Calcium, mmol/l	2.67±0.09	2.64±0.07	2.65±0.06	2.38±0.07*
Phosphorus, mmol/l	1.62±0.01	1.60±0.02	1.61±0.01	1.5±0.01*
Glucose, mmol/l	2.48±0.18	2.52±0.08	2.52±0.07	2.25±0.08*
Vitamin A, mmol/l	3.8±0.21	2.93±0.07	3.7±0.09	1.97±0.39
Vitamin C, mmol/l	38.3±1.29	34.67±1.82	37.87±2.09	28.67±2.33

Note: \* – the differences between the parameters in the control and experimental groups are statistically significant.

**Table 4.**

Results of pathologoanatomic autopsy of cows from EG-1 and control

Sex	Cow	Cow
Age	4	4
Hair Cover	Normal	Normal
Skin/Horn Cover	Normal, horn cover is firm	Normal, horn cover is firm
Lymph nodes	Normal, shape has not changed	Normal, shape has not changed
Skeletal muscles	Normal, the shape is well expressed	Normal, the shape is well expressed
Musculoskeletal system	Normal, no deviations in the structure of bones, sinews and joints	Normal, no deviations in the structure of bones, sinews and joints
Organs of the abdominal cavity	Normal, no displacement of organs position	Normal, no displacement of organs position
Organs of the thoracic cavity	Normal, no displacement of organs position	Normal, no displacement of organs position
Spleen	Normal, no deviations	Enlarged, properly shaped
Heart	Normal, no deviations revealed in the structure of muscular fibers, the heart is of the correct form	Normal, no deviations revealed in the structure of muscular fibers, the heart is of the correct form
Organs of the respiratory system	Normal, no deviations revealed in the structure of the larynx, trachea, bronchi and lungs	Normal, no deviations revealed in the structure of the larynx, trachea, bronchi and lungs
Organs of the digestive system	Normal	The liver is enlarged, hepatocytes without clear outline
Organs of the urinary system	Normal	The kidneys are enlarged in volume. Capsule is turbid. Pelvic cavities contain white-yellow fluid
Organs of the genital system	Normal	Normal

The addition of this clay to the preparation is due, above all, to its high adsorption capacity. In addition, several researchers have shown that montmorillonite plays a positive role in metabolic processes (Rong et al., 2019; Wang et al., 2022). Clay contains the necessary components for the successful functioning of organs and systems in the living body. It is known that mineral deficiencies can cause low productivity and fecundity of important farm animals. At the same time, the issue of the toxicity of montmorillonite clay is extremely controversial. In the current literature, there is evidence of the toxicity of montmorillonite (Guo et al., 2023). Other authors (Bezzekhami et al., 2023; Wang et al., 2023) believe that montmorillonite clay is safe, because it has no accumulative effect and there are no negative changes in the morphofunctional state of organs and systems of the living body when taking it. The research results indicate that oral administration of the developed veterinary preparation had no reliable influence on the indices of biochemical blood analysis in rats after 14 days after administration of the preparation. No deviations in the behavior of the experimental animals and their physiological characteristics were revealed as well. The obtained data is consistent with the results presented in 2022 by two independent groups of researchers led by Persano & Leporatti (2022) and Baek et al. (2022). In these papers, the authors also observed no abnormalities in rats that were orally injected with the montmorillonite-based preparation. Thus, the developed drug showed no negative biological effects when administered orally to rats and can be classified as a low-hazard substance. Application of the developed preparation for treatment of acute gastroenteritis in cattle of Kazakh whitehead breed testifies to its high efficiency. In the first experimental group, after 14 days of treatment, the percent recovered was 30% higher than in the control group, in which animals were subjected to the standard scheme of treatment. In the second and third experimental groups, the percentage of recovery also improved by 15% and 20%, respectively. Thus, with a 95% probability, it can be stated, that the preparation based on montmorillonite clay contributed to the recovery of animals from acute gastroenteritis. The results obtained are in good agreement with the data of Vasilyanova (2016). The author showed that the use of montmorillonite in the treatment of gastroenteritis in piglets stimulated the immune system and improved the results of the standard treatment scheme by 9%. It is interesting to note that piglets receiving montmorillonite recovered 3 days earlier compared to animals in the control group. The current literature also has infor-

mation about the high effectiveness of montmorillonite clay for the treatment of several infectious diseases caused not only by bacteria, but also by pathogenic fungi (Agougui et al., 2022; Chen et al., 2024).

The study of the preventive effectiveness of the preparation based on montmorillonite showed that adding the veterinary drug to the feed contributed to the effective prevention of gastroenteritis. In the experimental groups, 20 - 25% fewer animals fell ill compared to the control group, in which more than one-third of the livestock fell ill. Thus, adding the developed veterinary drug to the ration reduced the incidence of gastroenteritis in 2.3 - 3.5 times among cattle. Also, the drug had a positive effect on the mineral metabolism of animals. Thus, the concentration of phosphorus in the blood serum of animals from the experimental groups was significantly higher by 6.8% - 7.4% compared with the control group, and the concentration of calcium was higher by 11% - 12%. It can be assumed that the improvement of mineral metabolism is also due to the presence of gase and chalk in the veterinary preparation. Indeed, enrichment of feed with montmorillonite clay results in important mineral components in the diet of animals and is reflected in a significant improvement in such indicators as calcium (by 27%), iron (by 47%), copper (by 12.5%), zinc (by 26%) (Adamis et al., 2005).

Montmorillonite clay positively affect the growth and development of important farm animals, increasing calf weight gain by 6%, while the cost of feed decreased by 7% (De Baere et al., 2023). The study of clay with high content of montmorillonite from Taganskoe deposit in Kazakhstan shows that enrichment of animal diet with this clay improved the daily weight gain of piglets by 9%, while such an additive can increase the profitability of pig rearing by 11% (Vasilyanova, 2016). The data show no statistically significant difference in the number of erythrocytes and haemoglobin in the blood serum. It is worth noting that the literature contains information that montmorillonite can lead to significant improvements in haemoglobin and erythrocyte levels in animals (Liu et al., 2023; Lin et al., 2023). This issue requires further detailed study. The results also show a statistically significant increase in serum protein concentration of 19%, 9.8%, 11.7% (for EG-1, EG-2, and EG-3, respectively) compared to the control group, whereas glucose concentration increased by 10.1% - 12%, respectively. Analysis of scientific publications showed that the use of clay with high montmorillonite content activates protein and carbohydrate metabolism (Fiorito et al., 2008; Zhao., 2023). Interestingly, montmorillonite clay can

reduce concentrations of heavy metals, such as cadmium and lead, by 36% and 99%, respectively (Abdelnaby et al., 2022; Lahnafi et al., 2022).

Autopsy of cows from the first experimental and control groups revealed no significant deviations in the morphology of internal organs. Also, no pathological deviations were found in the structure of internal organs of experimental and control animals, except that the cow from the experimental group had slightly enlarged spleen, liver and kidneys. No pathological changes in the tissues of internal organs were detected as well. Thus, it can be argued that the use of a veterinary drug based on montmorillonite clay of Western Kazakhstan proved to be a highly effective solution for the prevention of gastroenteritis in experimental animals. In addition, montmorillonite has a favourable effect on carbohydrate, protein and mineral metabolism.

#### 4. Conclusions

The results obtained testify to the high quality of montmorillonite clay of Western Kazakhstan. Its chemical composition is mainly represented by two oxides: SiO<sub>2</sub> (61.51%) and Al<sub>2</sub>O<sub>3</sub> (17.06%). Such clay is characterized by an excellent ability to adsorb. In addition, it contains the components necessary for the successful functioning of important farm animals. In this research, a veterinary preparation based on montmorillonite clay (60%) was developed; it also included gaze (20%) and chalk (20%). All these mineral components were extracted from a deposit in Western Kazakhstan.

The study of toxicity of the new drug did not reveal negative biological effects in rats, which were orally administered the drug, so the developed drug belongs to the class of low-hazardous substances. With a 95% probability, it can be stated that the veterinary drug improves the results of the standard scheme of treatment of acute gastroenteritis in cattle by 15% - 30%. A veterinary drug based on montmorillonite also improved mineral metabolism in cattle. Enrichment of the animals' diet with this preparation led to the increase of phosphorus concentration in the blood serum by 6.8% - 7.4% and calcium concentration by 11% - 12% compared with the control group. Also, the drug had a positive effect on protein and carbohydrate metabolism. In the experimental groups, the protein concentration was significantly higher by 9.3% - 10%, and glucose was higher by 10.1% - 12% compared with the control group.

It can be stated with 95% probability that the addition of the veterinary drug to the feed contributed to the effective prevention of gastroenteritis. In the

experimental groups, 20% - 25% fewer animals fell ill compared to the control group, in which more than one-third of the livestock fell ill. Thus, the research goal was achieved. Application of veterinary preparation based on montmorillonite clay of Western Kazakhstan proved to be highly effective and safe solution for the prevention and treatment of gastroenteritis in cattle. This research creates the prerequisites for a more comprehensive study of the use of montmorillonite clay in the prevention and treatment of infectious diseases of cattle. The main prospects for future research are related to the development of veterinary preparations based on montmorillonite to increase productivity in different groups of economically important animals, as well as for the prevention and treatment of infectious diseases that cause serious damage to agriculture.

#### Conflict of interest declaration

The authors declare that they have no conflict of interest.

#### Author Contribution

Conceptualization, S. M., N. M.; methodology, N. M.; software, M. S.; investigation, M. S., N. M.; resources, N. M.; data curation, S. M.; writing—original draft preparation, M. S., N. M., S. M.; writing—review and editing, M. S., N. M., S. M.; visualization, N. M., M. S.

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