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Enterosorbent for endotoxicosis as a factor influencing the development of young cattle

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Abstract. **Purpose** – study the effect of enterosorbent on the immunological parameters of blood and the productivity of young cattle. **Methods.** The object of the study was newborn calves from 2 to 6 days of age (n = 54). Studies on the enterosorbent based on colloidal silicon dioxide (CSD) for calves with alimentary dyspepsia have been carried out. During the experiment, the clinical condition of the animals, the increase in live body weight were evaluated, blood samples were taken for immunohematological studies. **Results.** In calves at 2–6 days of age, alimentary dyspepsia is accompanied by the development of endogenous intoxication of the body. Animals show leukocytosis – 16.60 ± 5.11×10^9/l; leukocyte shift to the left with an increase in the number of adolescent and stab neutrophils – 1.41 ± 0.23×10^9/l; monocytes up to 1.21 ± 0.13x×10^9/l; circulating immune complexes (CIC) level in blood serum up to 202.4 ± 8.5 cu Under conditions of endogenous intoxication, the immunological protection of the organism was characterized by an increase in the number of phagocytic cells to 71 % of the total number of granulocytes. Clinical symptoms of endogenous intoxication in 86 % of cases disappeared by the 5th day of the use of enterosorbent CSD in the treatment regimen of calves with alimentary dyspepsia. This is associated with blocking and weakening the inflammatory response in the gastrointestinal tract. The effect of enterosorbent CSD on the immunological parameters was expressed in a balanced stabilization of the processes of phagocytosis and immunogenesis. The trend towards normalization of immunological parameters was registered: the level of the CIC was significantly reduced to 97.5 ± 5.48 cu; the phagocytic activity (PA) of the neutrophilic cells was 50.1 ± 2.4 %. Treatment of animals according to the basic scheme approved by the farm turned out to be less effective. In calves that did not receive enterosorbent CSD, in 11 % of cases, clinical manifestations of endogenous intoxication were recorded up to and including 14 days. In these animals, the level of the CIC remained high – 143.6 ± 8.57 cu, the voltage of phagocytic function was noted – 64.3 ± 7.6 % and the imbalance in the ratio of T/B-lymphocytes – 1.13 (normal 1.5–2.0). The effect of the CSD enterosorbent on the calves productivity was reflected in the fact that the rate of weight gain during the experiment was higher in the experimental group. At 4 months, their weight was 149.17 ± 13.57 kg, while in the control group and the comparison group – 135.00 ± 5.00 and 130.00 ± 22.73 kg, respectively. **Scientific novelty.** Alimentary dyspepsia causes the development of endogenous intoxication in the body of newborn calves. The lack of therapeutic measures leads to a long recovery period and a decrease in productivity.

Keywords: calves, immunology, dyspepsia, endotoxicosis, enterosorbent, colloidal silicon dioxide, productivity.

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Introduction

One of the significant causes of animal endotoxicosis is an essential antigenic load on the body as a result of the combined effects of natural and anthropogenic factors. Endogenous factors, which play a tangible role in the formation of allergic conditions most often occur in concomitant diseases of the respiratory system, skin and nervous system, diseases of the liver and kidneys, gastrointestinal tract (intestinal dysbiosis, dyspepsia) [1, p. 301; 2, p. 149]. Barrier impairment of the gastrointestinal tract facilitates the intake of xenobiotics in the mining and mineral processing industry, chemical and light industry, energy and agriculture, pharmaceutical and cosmetic industries. When they enter the body, many of them are subjected to neutralization and elimination very slowly, and long-term accumulation in organs and tissues leads to the development of endotoxemia and worsening of the disease [3, p. 12; 4, p. 62].

Endotoxicosis is a complex multifactorial pathological process that sequentially acquires a more universal character, depending on the main link – systemic tissue hypoxia, with all its complex metabolic consequences. Endogenous intoxication causes significant changes in the body: increased energy expenditure, tissue damage, metabolic and organ dysfunctions involved in detoxification [5, p. 139]. Therefore, it is necessary to approach comprehensively the correction of endotoxemia. This approach should be based on the mechanisms of pathogenesis, on the structure of endotoxemia, where the action of detoxicants is directed to systems and organs that are most susceptible to negative effects [6, p. 134]. The duration of treatment and the positive effect of the drugs is an important

criterion aimed at the speedy recovery and preservation of the genetic potential.

Alimentary dyspepsia of newborn calves is ubiquitous, in some cases the incidence rate reaches 85–100 %, and the death of animals is recorded in 30–50 % of cases [7, p. 198]. The disease is characterized by the progressive development of endogenous intoxication of the calf [8, p. 24; 9, p. 306]. At high concentrations in the body of natural metabolic products, ingredients of cellular apoptosis, bacterial toxins and similar substances, the detoxification and regulation systems of homeostasis cease to function fully, undergoing significant toxic damage. It should be noted that endogenous intoxication becomes an essential mechanism in the formation and maintenance of metabolic disorders. It causes the cascade of arising cellular reactions. These in turn form a pathological process of the type of «vicious circle», which is dangerous for the health and life of a newborn calf [10, p. 225]. Veterinary specialists apply complex regimens consisting of specific and symptomatic therapy to treat dyspepsia in newborn calves. Enterosorbents are most often used in complex therapy to reduce the severity of pathological conditions caused by endotoxicosis [11, p. 2; 12, p. 19].

Enterosorption is a modern and very effective detoxification method. Its therapeutic mechanism is associated with a direct and indirect effect. The direct effect is due to the physicochemical properties of enterosorbents – their ability to bind and remove exogenous substances, microorganisms and their toxins from the gastrointestinal tract. As a result, the processes of resorption, recycling of toxic substances are interrupted, which generally reduces the negative burden on the body [13, p. 145; 14, p. 32]. The indirect action of enterosorbents is the ability to break the accumulation chain of toxic metabolites in any link, block or weaken toxic-allergic reactions, reduce the load on organs involved in detoxification processes, normalize metabolic processes, and motor-evacuation function of the gastrointestinal tract. The main advantage of enterosorbents as pharmaceuticals is: their non-invasiveness, the absence of side effects and contraindications [15, p. 30].

Despite numerous studies concerning the detoxification properties of enterosorbents, the subject of constant discussion still is their effect on the immune status, especially in rearing young cattle.

Methods

The objective is to study the effect of enterosorbent on the immunological parameters of calf blood and the productivity of young cattle. The studies were carried out in Ural Research Veterinary Institute, Laboratory of Immunology and Pathobiochemistry, FSBI «Ural Federal Agrarian Research Center of the Ural Branch of the Russian Academy of Sciences», as part of the State Assignment under the 160 Program of the Federal Scientific Research Institute of State Academies of Sciences on the topic No. 0773-2019-0002 "Develop a scientifically-based system for the diagnosis, prevention and treatment of non-communicable diseases of farm animals and poultry". The research topic for 2019 is: "To study the factors affecting the productive and reproductive health of farm animals and poultry".

The object of the study are newborn calves from 2 to 6 days of age, kept in an agricultural enterprise of the Sverdlovsk region (n = 54).

Enterosorbent is a gel form of colloidal silicon dioxide – CSD (99.98 % of active silicon), designed to normalize digestion and reduce inflammation in the gastrointestinal tract, compensate for the lack of silicon in the body, stimulate the growth of young animals and birds.

According to the analogy principle, calves were divided into 3 groups with 18 animals in each group (Table 1).

In the 1st group ("comparison"), treatment of calves was carried out according to the scheme adopted by the agricultural organization: "Enroflox 5 %" injectable 5 ml subcutaneously; orally: "Replevac-BET" 100 g 2 times a day; "Tetracycline" 2.5 g 2 times a day; decoction of oak bark – 0.5 liters per day. This treatment regimen was designed for 5 days.

In the 2nd group ("experimental"), in addition to the traditional regimen, it was applied 40 g of enterosorbent CSD per head, twice a day, 30 minutes prior to receiving the colostrum (milk). The course of treatment was 5 days.

The third group ("control") – healthy calves, without the use of medical regimens and feed additives.

During the experiment, daily observations were made on the clinical condition of the animals. Blood for laboratory tests was taken in the morning from the jugular vein of calves: before the experiment (background) and after 5 and 14 days.

Hematological parameters were determined on an Abacus Junior Vet analyzer (Diatron, Austria) using standard reagents; the leukocyte formula was counted in blood smears stained according to Romanovsky – Giemsa. Immunological studies of animal blood were performed according to the method of Smirnov P. N.: determining the phagocytic activity (FA) of neutrophils and monocytes; the content of T and B lymphocytes. Immunological and hematological parameters were visually counted on a microscope Micros MCX 100 (Austria). The number of circulating immune complexes (CIC) in serum was recorded on SF UV-1800, manufactured by SHIMADZU (Japan).

Table 1

The scheme of scientific and production experience

Group No.	***Group of animals***	***Treatment***
1	*Comparison (n = 18)*	*The treatment of alimentary dyspepsia in newborn calves, adopted by the agricultural organization*
2	*Experimental (n = 18)*	*The treatment regimen of alimentary dyspepsia in newborn calves, adopted by the agricultural organization + enterosorbent CSD*
3	*Control (n = 18)*	*Without medicating*

Results

Clinical examination of newborn calves aged 2 to 6 days of age, which were kept in the dispensary, recorded disorders of the gastrointestinal tract in 36 animals. The cause of the disease was violations when colostrum was fed to young animals. Conducted additional diagnostic studies confirmed that the causative agents of acute intestinal infections are absent in the examined calves.

In sick animals, the following was recorded: inhibition of the general condition, a significant weakening of all motor reactions, dehydration reached 5–10 % of body weight. Calves with an upset gastrointestinal tract were placed in an isolation ward and received treatment according to the scheme of scientific and industrial experience. The comparison group consisted of 18 animals at the age of 3–5 days without clinical signs of gastrointestinal disorders. The dynamics of the sick calves' clinical condition is presented in Table 2.

The clinical condition of the 1st group was significantly improved on the fifth day of observation. However, the "residual" phenomena of the transferred disease are: reduced motor activity, pallor and dryness of visible mucous membranes, unformed feces. These symptoms were diagnosed until the end of the scientific and production experiment in 11 % of calves.

Positive dynamics of the clinical condition in animals of the 2nd group was observed by the third day in 29 % of cases. In addition, on the fifth day of the scientific experiment, only 14 % of the calves had unformed feces. By the seventh day, the clinical symptoms of diarrhea with endotoxicity syndrome were absent.

In the third group ("control"), clinical manifestations of diarrhea were not registered for the entire observation period, and the calves' health status corresponded to physiological age norms.

The results of hematological studies of background blood samples taken during a clinical examination of calves confirmed the presence in animals of the first and second groups the inflammatory process with symptoms of dehydration and intoxication (endotoxemia). Leukocytosis was recorded in sick animals – 16.60 ± 5.11×10^9/l, healthy calves had a white blood cell count of 7.82 ± 1.43×10^9/l. In addition, a shift of the leukocyte formula to the left was observed with an increase in the number of young and stab neutrophils – 1.41 ± 0.23×10^9/l (healthy animals – 0.53 ± 0.07×10^9/l). In the blood serum, the level of CIC was 134.00 ± 18.38 units (119.41 ± 2.45 units – healthy animals). The relative number of immunocompetent cells of T- and B-lymphocytes in sick animals did not dif-

Table 2

The results of monitoring the clinical condition of sick calves with gastrointestinal disorders

Group of animals	*The number of animals with clinical manifestations of the disease (%)*				
	1 day observation	*3 day observation*	*5 day observation*	*7 day observation*	*14 day observation*
Comparison (n = 18)	100	100	57	30	11
Experimental (n = 18)	100	71	14	0	0
Control (n = 18)	0	0	0	0	0

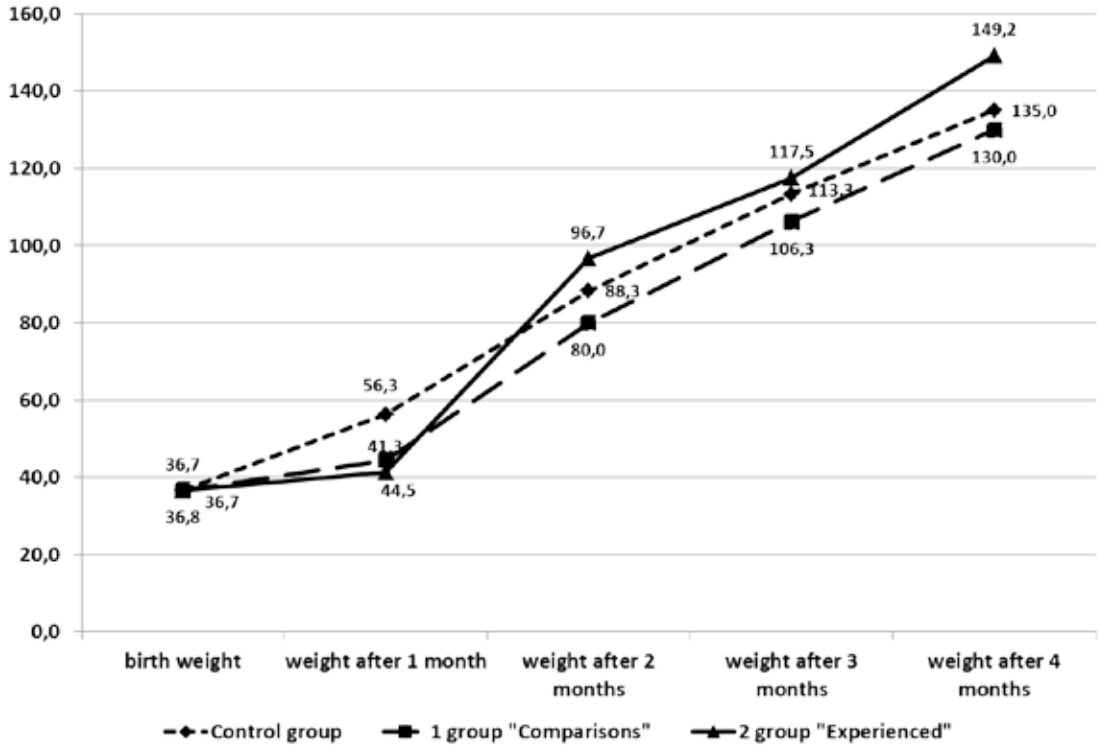

Fig. Dynamics of change in body weight of calves

fer significantly from that in healthy calves – T-lymphocytes 39.1 ± 1.5 %, B-lymphocytes 29.4 ± 2.7 %. The phagocytic activity of cells in the first and second groups averaged 66.3 ± 4.7 %, which is 1.5 times higher than in the third group "control" – 47.2 ± 1.8 %. The results of the study showed that the most stable form of immunological defense, phagocytosis, dominates in the examined calves with endogenous intoxication.

During the study of the main immunological parameters in dynamics, it was noted that in the first group, by the 5th day of observation, monocytes were involved in the processes of phagocytosis in addition to neutrophils, their number increased to 1.21 ± 0.13×10^9/l. Animals of the second group had the number of monocytes in the blood in the amount of 0.36 ± 0.09×10^9/l, the calves of the third group had – 0.25 ± 0.08×10^9/l. The activity of the inflammatory response remained high – the level of the CIC was 202.4 ± 8.5 units (background level was 152.3 ± 4.6 units).

The second group was registered a tendency to normalization of immunological parameters during treatment enterosorbent CSD. First of all, a decrease in the activity of the inflammatory reaction was noted – the level of CIC significantly decreased to 97.5 ± 5.48 units (background level was 149.6 ± 8.57 units). Compared with the background values, the number of phagocytic cells of the neutrophilic series did not change significantly (67.3 ± 2.4 % and 66.3 ± 4.7 % respectively). However, it should be noted that phagocytosis involved mainly segmented neutrophils.

On the 14th day of observation, calves of the first group showed a decrease in the activity of the inflammatory reaction in the intestinal tissues, which contributed to the stabilization of immunological parameters (Fig.). However, the detoxification processes in animals were not completed. The level of the CIC remained high – 143.6 ± 8.57 units, phagocytic activity – 64.3 ± 7.6 %. There was an imbalance in the ratio of T/B lymphocytes – 1.13, healthy animals have 1.5–2.0. In the second group of calves, during this period, the ratio of T/B-lymphocytes is 1.54; the third group has 1.64.

On the 14th day of observation, in the second group of calves which were treated with the enterosorbent CSD, the main immunological parameters did not significantly differ from the indicators of the third group.

Observations of changes in the physical development of calves were carried out up to 4 months of age.

Newborn calves had live weight at birth 36.7–36.8 kg. Monthly monitoring of live weight gain revealed significant differences between the groups. The calves of the control group, without characteristic signs of dyspepsia, at one month of age had a live weight of 56.33 ± 0.58 kg. The first and second groups of animals that suffered from alimentary dyspepsia gained weight slower than their peers by 21.0 % and 26.6 %, respectively (fig.).

The dynamics of observations in the increase in body weight by the end of the 2nd month revealed the following changes. The calves of the control group had a live weight of 88.33 ± 2.89 kg, and the animals of the first group, which were treated according to the traditional scheme, weighed 80.00 ± 9.31 kg, which was lower by 9.4 %. A more significant increase in live weight was recorded in the second group – 96.67 ± 4.87 kg, where in addition to the traditional scheme, CSD enterosorbent was used.

Until the end of the observation period, this pattern persisted. The highest increase in live weight was recorded in the experimental group – 117.50 ± 12.15 kg at 3 months and 149.17 ± 13.57 kg at 4 months. The comparison of the experimental group with the control group was 3.7 % and 10.5 %. In the same periods, the live weight of calves in the experimental group was lower than in the control group – by 6.2 and 3.7 %, respectively.

Studies have shown that the main mechanism of immunological protection in young cattle of the first month of life, which has dyspeptic disorders, is phagocytosis. The results obtained are consistent with the results of previous studies and literature data [1, 3, 4, 7]. The use of enterosorbent based on colloidal silicon dioxide in the treatment regimen allowed to reduce the toxic load on the body of calves within 5 days. Blocking and attenuation of the inflammatory reaction in the gastrointestinal tract was recorded in animals. The directed action of the enterosorbent CSD on immunological parameters was manifested in a balanced stabilization of the processes of phagocytosis and immunogenesis. The phagocytosis of toxic antigens involved mainly mature forms of neutrophils. The activity of the cells of the monocytic link was insignificant and was recorded only at the initial stage of the disease. Changes in the quantitative composition of immunocompetent cells of the lymphoid series – T- and B-lymphocytes had slight fluctuations and corresponded to age-related physiological norms.

Discussion and Conclusion

As a result of the studies, it was found that the complex treatment of calf dyspepsia with endotoxemia according to the traditional scheme adopted in an agricultural enterprise, using CSD enterosorbent, within 5 days reduced the manifestations of clinical signs of diarrhea on the 3–5 day, and recovery came on the seventh day. The treatment measures carried out in similar conditions, according to the basic scheme approved by the farm, in our case were less effective.

In addition, the use of colloidal silicon dioxide enterosorbent, in combination with the traditional therapy regimen, had a significant effect on immunological parameters. The time to normalize the values of the neutrophilic and phagocytic reactions of the immune system decreased, and the process of clinical recovery of animals accelerated, which contributed to a more intensive increase in live weight.

References

1. Oparina O. Yu. Changes in the overall resistance of the body in young farm animals during the correction of intestinal microbiocenosis (review) // Ecological and biological problems of the use of natural resources in agriculture Materials of the International scientific and practical conference of young scientists and specialists. Ekaterinburg, 2017. Pp. 300–305.

2. Sokolova O. V., Shkuratova I. A., Ryaposova M. V., Belousov A. I. The use of micellar bioelements in the technological cycle of calf rearing // Actual problems of biology in animal husbandry Materials of the Sixth International Conference. Borovsk, 2015. Pp. 149–150.

3. Belko A. A., Velikanov V. V., Petrov V. V., Gromov I. N., Malkov A. A., Zhukova Yu. A., Alaradzhi F. S. K. Enterosorbents in clinical veterinary practice: recommendations // Vitebsk: VGAVM, 2016. P. 22.
4. Shkuratova I. A., Shilova E. N., Sokolova O. V. Veterinary and sanitary aspects of the prevention of diseases of young cattle in modern industrial complexes // Problems of veterinary sanitation, hygiene and ecology. 2015. No. 3 (15). Pp. 60–63.
5. Donnik I. M., Shkuratova I. A. Molecular-genetic and immunobiochemical markers in assessing the health of agricultural animals // Herald of the Russian Academy of Sciences. 2017. T. 87. No. Pp. 139–142.
6. Smolentsev S. Yu., Polikarpov I. N., Papunidi E. K. Evaluation of the use of complex treatment for the pharmacocorrection of gastroenteritis of calves // Scientific notes of Kazan State Academy of Veterinary Medicine named after N. E. Bauman. 2017. T. 231. No. 3. Pp. 133–135.
7. Erokhin V. V. The effect of enterosorbent on hematological indicators of heifers / Collection of scientific papers of the All-Russian Research Institute for Sheep and Goat Breeding on the materials of the international conference "Innovative Developments of Young Scientists – Development of the Agro-Industrial Complex". Stavropol, 2014. V. 3. Issue 7. Pp. 196–200.
8. Gertman A. M., Asoskova E. M. Treatment of gastroenteritis of calves in the natural and technogenic province of the Southern Urals // Scientific notes of the Kazan State Academy of Veterinary Medicine named after N. E. Bauman. 2017. T. 231. No. 3. Pp. 22–27.
9. Shparkovich M. V., Malkov A. A. Methods of treatment and prevention of gastroenteritis in piglets using enterosorbents // Ecology and Innovation. 2018. Pp. 306–307.
10. Sokolova O. V., Belousov A. I., Zaitseva O. S. Characteristics of the immune system and metabolism of newborn calves in the Ural region // Ecological and biological problems of the use of natural resources in agriculture: materials of the Intern. scientific-practical conf. Ekaterinburg, 2016. Pp. 224–228.
11. Arkhitskaya E. V., Yakushkin I. V. Practical value and effectiveness of the use of enterosorbents in animal husbandry [e-resource] // Electronic Scientific and Methodological Journal of Omsk State Agrarian University. 2016. Special issue No. 2. URL: http://e-journal.omgau.ru/index.php/spetsvypusk-2/31-spets02/400-00149 (appeal date: 06.08.2019).
12. Velikanov V. V., Belko A. A., Ignatenko A. S., Gaponenko S. S., Subbotina I. A. Enterosorbents and prebiotics in the prevention and treatment of pathology of the gastrointestinal tract in animals // Scientific notes of the educational institution of the Vitebsk Order badge of honor State Academy of Veterinary Medicine. 2015. No. 2. Pp. 19–22.
13. Kubatbekov T. S., Kosilov V. I., Daminov R. R., Rystsova E. O., Kulikov E. V., Korablina V. Yu. Pharmacotoxicological characteristics of enterosorbent ecosil and its use in veterinary practice // Bulletin of the Orenburg State Agrarian University. 2019. No. 1 (75). Pp. 144–146.
14. Vasilevich S. F. Probiotic-enterosorbent Sorbolin, production technology and application efficiency in cattle breeding: the diss. ... candidate of biological sciences: 03.01.06. Moscow, 2018. 166 p.
15. Bazhinskaya A. A., Merzlenko R. A., Artyukh V. M. Influence of enterosorbents "mycosorb" and "carbosil" on the physiological state of calves // Dairy and beef cattle breeding. 2017. No. 5. Pp. 29–31.

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