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THE ACTION OF THE MINERAL SUPPLEMENT "PMVAS" AND THE THERMAL FACTOR ON SOME TRACE ELEMENTS IN CALVES IN THE POSTNATAL PERIOD

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Abstract

This paper reflects the research carried out regarding the status in copper, zinc and iron depending to the intake of the mineral supplement `PMVAS` and establishing the correlation between the action of the food factor and the action of the low temperature of a moderate stress intensity on the organism of the calves in the early postnatal period. Thus, the paper presents the results of the separate action of the mineral premix `PMVAS` and its conjugate with the thermal factor on some indices of saline metabolism in calves in postnatal period carried out in order to correct the deficiency of trace elements and determine the parameters that can act beneficially on homeostasis, resistance and adaptive capacities of animals to the action of the environment. At the separate and combined application of the factors studied in dynamics (7, 30, 60, 90 days) on the organism of the calves were obtained representative data regarding the functional state of the organism demonstrating a moderate intensification of the metabolism of trace elements.

Key words: *calves, mineral supplement, stress, temperature, trace elements.*

INTRODUCTION

The state of salt metabolism of calves in the early postnatal period especially of trace elements depends on the liver reserves that they obtained at birth from their mothers and from the milk consumed. These sources could be insufficient in farms where intensive growing technologies are practiced because young animals are particularly sensitive to trace element deficiencies, which manifest themselves more pronounced and in a more acute form than in adult animals (Lamand & Lamand, 2013; Usachiov & Strelitzov, 2019). Trace elements exert their effect in the composition of enzyme systems and participate in various metabolic processes, which are especially intense in young, fast-growing animals. The occurrence of micronutrient deficiency in an animal depends on the intensity of the growth process (Furdui, 1986; Furdui et al., 1992; Cheghina, 1993; Lorenz et al., 2011; Iakushkin, 2012).

Essential trace elements are present in an almost constant amount in the body, they cause structural and metabolic anomalies by their absence, they prevent or correct these anomalies by their intake. The intake of an optimal amount of trace elements is generally ensured by a balanced diet, but it may be insufficient if the composition of the diet mainly consists of foods from intensive crops or the foods are intensively processed, preserved or thermally processed (Strutinschi, 1997). There are physiology situations such as growth in which an additional supply of trace elements is required. Long-term exposure to certain risk factors such as unbalanced nutrition, stress, pollution, can also increase the need for trace elements (Kurbanalieva, 1982; Mashkina & Stepanenko, 2017; Medvedev & Sokolova, 2019).

The success of raising productive animals depends on the effectiveness of prophylaxis and correction of various deviations of homeostasis in adult cattle and particularly in calves in the early postnatal period (Jegou et al., 2006; Gonsales Martin & Elivira Partida, 2011; Bociarov, 2015). This can be easily achieved by supplying the young organisms with qualitative nutrients in optimal quantities and eliminating from the organism the useless products obtained as a result of metabolism (Dorosh, 2007; Dronov, 2000). However, at the present time, there are frequently recorded deficiencies of trace elements that affect the functions of hematopoiesis, endocrine glands, defense reactions of the body, microflora of the digestive tract, regulation of metabolism and biosynthesis of proteins (Heinrichs & Radostits, 2001; Kraskovo, 2005; Kucinskii, 2007; Zavalishina et al., 2011). The acute trace element deficit requires expenditure to correct and undertake veterinary medical prophylactic measures to combat various complications which in turn lead to additional animal losses (Kurbanalieva, 1982; Gaidukova et al., 2003; Karashaev, 2007; Marie-Vinciane, 2008). The most important trace elements for the organism of animals in the early postnatal period are "essential trace elements with demonstrated risk of deficiency" such as iron, copper and zinc. The importance of iron for the body is determined by its ability to bind and transport oxygen and participate in cellular respiration (Shedrunov et al., 1989). Iron is a fundamental constituent of hemoglobin and its absence can cause iron deficiency anemia. Iron is also part of the structure of myoglobin (it ensures the oxygen reserves of the muscles) and of numerous enzymes. The periods in which preventive supplementation of iron intake is necessary is the period of early postnatal ontogenesis (Karashaev, 2007; Zavalishina et al., 2011).

Copper is considered an anti-infectious, anti-inflammatory, and anti-oxidant agent, plays a significant role in the process of hematopoiesis as a biocatalyst that stimulates the formation of hemoglobin from inorganic iron compounds. At a lack of copper in the diet of cows and young animals, immature forms of erythrocytes appear in the blood which lead to aggravation of anemia. Copper is also essential for the normal development of the skeleton, plays an important role in the synthesis of cartilaginous tissues and intervenes in bone mineralization, in the regulation of nerve signal transmission at the brain level. With a copper deficiency in the feed, infectious states and rickets-like phenomena are observed in calves. Copper is also considered a powerful factor in reducing oxidative stress (Nazdrachova, 2004; Kurdenko et al., 2017).

Zinc is an essential trace element involved in protein synthesis, it is part of the structure of more than 300 hormones and enzymes. It has an important role in cell division, being involved in the synthesis process of DNA and RNA. It is indispensable for the action of vitamin A, influences the activity of the pituitary hormones regulating the activity of the gonads (ovaries or testicles) FSH and LH, enters in the composition of insulin, helps to transform thyroxine (T4) into triiodothyronine (T3). Zinc also intervenes in maintaining the integrity of the immune system. Although the daily requirement is small, it is indispensable for the proper functioning of the calves' organism.

Supplementing with minerals of cattle rations is important also for the farmer who could benefit from a better productivity of the owned animals and therefore a better financial gain if the status in trace elements of the animals would be adequate. From the moment the animals are deficient, the products obtained from them are also deficient. There are studies that demonstrate that supplementing animal rations with macro- and microelements has a positive effect on the human organism.

In order to correct the deficiency of trace elements, we proposed to study the action of the mineral premix "PMVAS" on the organism of calves in the early postnatal ontogenesis, applied separately and conjugated with the abiotic environmental factor (temperature) of moderate stress intensity. The additional application of the thermal factor of a moderate stress intensity on the calves was carried out with the aim of stimulating the adaptive capacities and resistance of the animals to environmental factors and normalizing the physiological parameters of the organism in the early postnatal period.

MATERIALS AND METHODS

As a research object in this study, 30 calves of the Black-and-White breed were selected, divided into the control group (LM) and two experimental groups (LEP and LETP).

In order to correct the saline metabolism and increase the adaptive capacities of the organism, the action of the mineral compound "PMVAS" was studied, applied separately or conjugated with the thermal factor on calves in the postnatal period. The premix "PMVAS" was developed in the Institute of Physiology and Sanocreatology and contains cobalt carbonate, copper sulphate, iron sulphate, potassium iodate, manganese sulphate, zinc sulphate, sodium humate and calcium phosphate. The quantity of mineral substances was calculated based on the recommended norms, the content of mineral substances in the blood of animals and their feed value. This concentration constituted various values contained in the range from 0,1 mg to 100,0 g.

The study was conducted from the 7th day to the 90th day of postnatal ontogenesis.

The animals from LM, LEP and LETP during the research period were in similar maintenance conditions. Calves received the same ration, which was composed of hay, silage and concentrated fodder according to existing norms. In addition, each calf in all batches during the entire study period consumed 300 liters of whole milk.

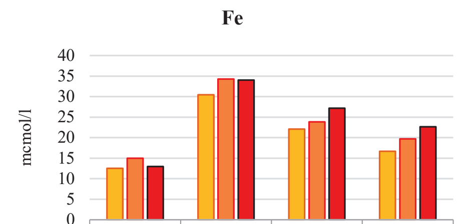
The differences between the rations of the calves consist in the fact that the animals in the experimental groups LEP and LETP in addition to the basic ration received a compound of mineral substances "PMVAS" in the amount of 1.5 g per 1 liter of milk consumed.

At the same time, the calves in the LETP experimental group, in addition to the procedures carried out in the LEP, were subjected to the action of the low temperature. As a stress factor the temperature of +5ºC was applied. The application of the temperature on the calves was carried out during the postnatal period at the age of 3, 7, 15, 20, 25 and 30 days. After introduction into the climatic chamber "Zootron" and adaptation of the animals for 1 hour to the new conditions, the temperature is gradually lowered to +5ºC. The temperature drop lasts 30 minutes. Exposure of animals to "low temperatures" at the age of 3, 8 and 15 days lasts 1 hour, and at the age of 20, 25 and 30 days - 2 hours.

Blood samples were collected at the age of 7, 30, 60 and 90 days. In order to appreciate the separate action of the mineral premix "PMVAS" and its conjugate action with the thermal factor on the functional state, resistance and adaptive capacities of calves, the amount of iron and copper in the blood was studied by the photoelectrocolorimetric method in the modification of Cuznetzov, zinc in the blood by the photoelectrocolorimetric method according to Cebotariova. The processing of the obtained data was carried out using methods established for the biological field (Merkurieva, 1963; Ivanter, 2010).

RESULTS AND DISCUSSIONS

In the present study was investigated the dynamics of the concentration of iron, copper and zinc, trace elements considered important for the organism. The obtained results of the amount of iron in the blood plasma of calves are presented in Figure 1.



	7	30	60	90
LM	12,53	30,43	22,08	16,71
LEP	14,98	34,31	23,87	19,69
LETP	12,95	34,01	27,15	22,67

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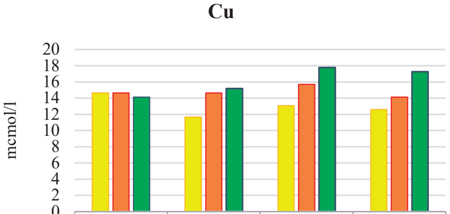
Figure 1. The amount of iron in the blood of calves subjected to the separate and conjugated action of the food factor with the thermal factor

Note: Here and hereafter: LM - control group; LEP - experimental group in which the "PMVAS" premix was administered; LETP - experimental group in which the "PMVAS" premix and the thermal factor were administered.

The data of Figure 1 demonstrates that the amount of iron in the blood plasma of calves varies depending on the period of application of the studied factors and the nature of these factors. Iron is an important and effective index in the prophylaxis of iron-deficiency anemia (Anokhin et al., 2003). The analysis of the iron content in the animals subjected to the experiment demonstrates a significant increase in its level in blood plasma in calves of all groups subjected to the experiment at the age of 30 days (P<0,05). In the later periods of the experiment (60 and 90 days) the amount of iron in all three groups is reduced in comparison with its value at the age of 30 days. Although

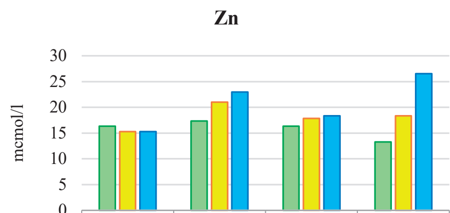
the amount of iron in the blood plasma with age tends to decrease in all groups, however, its higher values were recorded in the experimental groups. For example, at the age of 30 days, the amount of iron in LEP was 34.31±1.82, in the LETP group - 34.01±4.51, while in LM - 30.43±2.74 mcmol/l. At 60 days, the iron level in LM decreased to 22.08±2.60, in LEP to 23.87±1.58 ($P<0.05$) and in LETP to at 27.15±1.96 mcmol/l. A similar dynamic was preserved at the age of 90 days, constituting values of 16.71±1.15 ($P<0.05$), 19.69±1.03 ($P<0.05$) and 22.67±3.63 mcmol/l, corresponding to LM, LEP and LETP.
At the same time, it is noted that in the age periods of 7 and 30 days the amount of iron in LEP is higher than in LETP, then its content in LEP decreases in the following age periods of 60 and 90 days compared to LETP. This state of affairs demonstrates that initially a more pronounced influence on the iron content in the blood serum is provided by the separate administration of the food factor, then in the second half of the experiment in the upper position is placed the conjugate action of the food factor with the thermal one. The higher amount of iron recorded in the experimental groups according to the properties exerts an important action in respiration and tissue nutrition thus contributing to the prophylaxis of anemia and enhancement of the immunological reactivity of animals.
Next, the amount of copper in the blood plasma of the animals subjected to the experiment was studied. The obtained results are presented in Figure 2.



	7	30	60	90
LM	14,65	11,67	13,08	12,61
LEP	14,65	14,65	15,7	14,13
LETP	14,13	15,18	17,79	17,27

Figure 2. The amount of copper in the blood of calves subjected to the separate and conjugate action of the food factor with the thermal factor

Analyzing the amount of copper in the blood serum (Figure 2) it is marked that throughout the research period the amount of copper in the experimental groups is higher compared to that in the control group. At the same time, we mention that the conjugate action of the researched factors is more pronounced on the quantity of copper compared to the separate action of the food factor. The amount of copper in LETP is higher than its amount in LEP during the entire duration of the experiment and at the age of 60 and 90 days it constituted 17.79 and 17.27 mcmol/l.
Thus, the high level of copper in all experimental groups conditions the increase of hemopoiesis, the activity of the rumen microbiota, the functional state of the endocrine and nervous system, the development of bone system and increase of productivity of animals.
Since zinc is involved in protein synthesis, it is part of the composition of many hormones and enzymes, we considered it appropriate to study its evolution to the action of the investigated factors. The obtained results are presented in Figure 3.



	7	30	60	90
LM	16,32	17,34	16,32	13,26
LEP	15,3	21,01	17,85	18,36
LETP	15,3	22,95	18,36	26,52

Figure 3. The amount of zinc in the blood of calves subjected to the separate and conjugated action of the food factor with the thermal factor

From the data in Figure 3, it is denoted that the concentration of zinc in the blood of the animals in all groups subjected to the experiment oscillates, registering maximum values at the age of 30 days. In LEP and LETP the zinc values at the beginning of the experiment are equal (15.3 and 15.3 mcmol/l). Then, under the conjugate action of the studied factors (LETP), its quantity essentially increases throughout the study period, exceeding the value of zinc in the blood plasma in calves from the experimental group (LEP), in which only the food factor was applied (at 90 days $P<0.05$). The large amount of zinc obtained experimentally according to its properties influences the activity of the prestomach microbiota, adjusts the reproductive function and participates in the formation of bone tissue. Zinc deficiency in calves depends to a certain extent on the content of this trace element in cow's milk, that is, on the presence of this trace element in the mother's body. Meanwhile, despite the fact that zinc is very well absorbed by the calf from milk, it happens that the calf subsequently shows symptoms of zinc deficiency, probably due to a change in the absorption of this element by the calf. In this case under such circumstances, it is desirable to increase the zinc content in the diet of calves (up to 40-50 mg/kg SM).

CONCLUSIONS

Following the evaluation of the action of the studied factors, applied either separately or conjugately, on the organism of the calves in the postnatal ontogenesis and especially on the quantity of trace elements, it is possible to conclude that they provide a more optimal oscillatory level of iron, copper and zinc in the blood. The changing nature of the level of these elements in the blood plasma of experimental animals reflects not only their quantity, which arrives in the body through the food ration, but also peculiarities of their metabolism.

At the same time, we mentioned that the amount of the elements studied in LETP is higher compared to LEP. This increase is recorded throughout the experimental period, which confirms a beneficial and synergistic action of the studied factors on the organism of the calves in the early postnatal period, which is expressed by potentiating of their effects on the studied trace elements.

The obtained results demonstrate that the elaborated mineral premix, administered to animals in the amount of 1.5 g/l of milk, and the application of the thermal factor show positive effects on the productivity of animals in postnatal period. Thus, the daily weight gain of calves in LEP and LEPT was higher, correspondingly, by 70 and 62 g than in LM.

Thus, the researches carried out open numerous perspectives both at a practical and fundamental level. It is appropriate to review the intake and evolution of other trace elements in calves in the early postnatal period. Analysis of the effectiveness of a supplement in trace elements could be performed by comparing blood status and health, production and reproductive performance, depending on the form and amount of minerals consumed by animals. The quantitative parameters of trace elements should be recalculated according to the breed and performance of the animals, but also depending to the form of minerals ingested.

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