THE ACTION OF THE FOOD AND THERMAL FACTOR ON THE SALINE METABOLISM IN CALVES IN THE POSTNATAL PERIOD

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Abstract. The paper presents the results of the separate testing of the mineral premix "PMVAS", as well as in conjunction with the thermal factor of a moderate stress intensity on saline metabolism in calves in order to determine the parameters that can condition the homeostasis, resistance and adaptive capacities of animals to the influence of the environment. Upon the separate and combined application of the studied factors in dynamics (7, 30, 60, 90 days) on the organism of the calves, original data were obtained regarding the functional state of the organism. An increase in calcium, phosphorus, potassium, sodium, magnesium and their ratio were found, which denotes a relative restructuring of macroelements metabolism in dynamics. The oscillatory character of the values of these elements in the blood of experimental animals reflects on the one hand the amount of macroelements that come into the body through the food ration, and on the other hand the peculiarities of their metabolism. At the same time, we mention that, throughout the study period, the quantity of macroelements studied in the group in which the food factor was applied in conjunction with the thermal factor is higher than their quantity recorded in the calves from the group in which only the food factor was applied. Thus, a synergistic action of the studied factors is noted, expressed by the potentiation of their effects on the studied macroelements. In the context of the above, we mention that, depending on the separate or joint application of the studied factors, different results of the saline metabolism indices are obtained, with a moderate intensification of the macroelements metabolism in age dynamics and an optimal maintenance of the osmotic balance of the cytosol and extracellular fluid in the calves' bodies.

Keywords: mineral premix, temperature, calves, macroelements.

Rezumat. Acțiunea factorului alimentar și termic asupra metabolismului salin la viței în perioada postnatală. Lucrarea prezintă rezultatele testării separate a premixului mineral "PMVAS" și conjugată cu factorul termic de o intensitate stresorică moderată asupra metabolismului salin la viței pentru determinarea parametrilor care pot condiționa homeostaza, rezistența și capacitățile adaptive ale animalelor față de influența mediului ambiant. La aplicarea separată și conjugată a factorilor studiați în dinamică (7, 30, 60, 90 zile) asupra organismului vițeilor au fost obținute date originale referitoare la starea funcțională a organismului. S-a constatat o creștere a calciului, fosforului, potasiului, sodiului, magneziului și raportului lor, ceea ce denotă o restructurare relativă a metabolismului macroelementelor în dinamică. Caracterul oscilator al valorilor acestor elemente în sângele animalelor experimentale reflectă pe de o parte cantitatea macroelementelor care parvine în organism prin rația alimentară, și pe de altă parte particularitățile metabolismului acestora. Totodată, menționăm că pe toată perioada de studiu cantitatea de macroelemente studiate în lotul în care s-a aplicat conjugat factorul alimentar cu cel termic este mai mare decât cantitatea acestora înregistrate la vițeii din lotul în care s-a aplicat doar factorul alimentar. Astfel se notează o acțiune sinergică a factorilor studiați exprimată prin potențarea efectelor acestora asupra macroelementelor studiate. În contextul celor expuse menționăm că în funcție de aplicarea factorilor studiați separat sau conjugat se obțin rezultate diferite ale indicilor metabolismului salin, în organismul vițeilor are loc o intensificare moderată a metabolismului macroelementelor în dinamica vârstei și o menținere optimală a echilibrului osmotic al citosolului și lichidului extracelular.

Cuvinte cheie: premix mineral, temperatură, viței, macroelemente.

INTRODUCTION

In the period of postnatal ontogenesis, calves are largely exposed to the influence of the external environment and the technologies and methods of animal husbandry. In most cases, environmental factors have a joint impact on the animal organism and the result of their action depends on their nature and intensity. More than that, the effects that appear after their joint or separate influence are different and are seen in profound changes in the physiological processes of the organism (CEGHINA, 1993; IAKUȘKIN, 2012; KURDEKO et al., 2017; MEDVEDEV & SOKOLOVA, 2019). Depending on the degree of exposure to environmental conditions, the organism of newborn calves responds to the action of these factors either through adaptation reactions or through non-adaptation reactions (KUCINSKII, 2007; MAȘKINA & STEPANENKO, 2017).

In higher organisms, the temperature of atmospheric air is considered as the abiotic factor of the environment with the most important impact, both directly and indirectly, which exerts a special influence on the development and growth of the organism. The second most important abiotic factor is considered to be the food factor (GOLOKHVAST & CHAIKA, 2011; BOCHAROV, 2015).

The researches carried out on animals in postnatal ontogenesis have shown that, during this period, a large number of functional disorders of the body are recorded (USDA, 1997; JEGOU et al., 2006; GONZÁLEZ & ELVIRA, 2011).

It is known (SIDOROV & GUȘIN, 1984; FURDUI, 1986; FURDUI et al., 1992; STRUTINSCHI, 1997) that approximately 60-70% of the herd of calves show disorders of the digestive tract. Heinrichs & Radostits (HEINRICHS & RADOSTITS, 2001) state that 75% of calf deaths in the first 3 months after birth are caused by disorders of the gastrointestinal tract. The main cause of these disorders is the immaturity of calves, which is conditioned by the lack of balanced rations and the unfavorable influence of technological factors on pregnant cows, as well as on calves in the first days of life (TELIȚOV & ILIIN, 1993; MARIE-VINCIANE, 2008; VOLKOV et al., 2010).

The biochemical analysis of the blood of the calves shows that a large number of macro- and trace elements are below the limits of the recommended norms or at their lower limits (DRONOV, 2000; KOLESNICENKO & KULINSCHII, 2004; NAZDRACIOVA, 2004; USACIOV & STRELIȚOV, 2019). This state strains the systems which ensure the internal homeostasis of the organism, leads to overload and to the appearance of various ailments (LORENZ et al., 2011). It is obvious that the basic food ratio of calves does not ensure the normal state of homeostasis and can be classified as a stressing factor of moderate stress intensity. As a result, functional disorders and conditions appear, whose correction requires the development of mechanisms that would optimize homeostasis. Scientific research must be carried out currently to determine the influence of the combined action of environmental factors on the functional state, resistance and adaptive capacities of the organism in early postnatal ontogenesis. Moreover, the study of the action of environmental factors is of particular interest for determining the parameters that can be used as a way to increase the resistance and adaptive capacities of calves against the unfavorable action of the environment (BROUČEK, 2014; KURDEKO et al., 2017; MEDVEDEV & SOKOLOVA, 2019).

In the conducted research, we studied the influence of the separate action of the "PMVAS" premix and the influence of the combined action of the "PMVAS" mineral premix with the thermal factor of a moderate stress intensity on the saline metabolism of calves in early postnatal ontogenesis.

MATERIAL AND METHODS

The scientific researches were carried out on calves of the Black-and-White breed, selected taking into account age, sex and weight, divided into the control group (LM), and two experimental groups (LEP and LEPT).

For the correction of the saline metabolism and the increase of the adaptive and productive capacities of the animals, the action of the "PMVAS" mineral premix was studied, applied separately or in conjunction with the thermal factor of a moderate stress intensity on the calves in the postnatal ontogeny. The "PMVAS" premix was developed by the Institute of Physiology and Sanocreatology and contains cobalt carbonate, copper sulfate, iron sulfate, potassium iodate, manganese sulfate, zinc sulfate, sodium humate, calcium phosphate and excipient in variable concentrations in range from 0,1 mg to 100,0 g.

The study was carried out in accordance with the growing periods of the calves, which included the time span from the 7^{th} day to the 90^{th} day of life, a period in which the increase in the adaptive capacities of the calves takes place.

During the study, calves in the LM, LEP and LEPT groups were under similar maintenance conditions and received the same food ration, which was composed of hay, haylage, silage, concentrated feed and was consumed by the animals in unlimited quantities. In addition, each calf from all batches during the research period consumed 300 litres of milk.

The differences between the food rations administered to the calves consist in the fact that the animals in the LEP and LEPT groups added to the basic ration received the "PMVAS" mineral premix in the amount of 1,5 g per 1 litre of milk consumed.

At the same time, the calves in the LEPT group, in addition to the performed procedures, were subjected to the temperature action of a moderate stress intensity. The temperature of +5 ºC was applied as a stress factor. The application of the temperature on the calves was carried out at the age of 3, 7, 15, 20, 25 and 30 days of postnatal ontogenesis. After introducing the animals into the "Zootron" climatic chamber, the temperature is gradually lowered from the temperature recorded in the "Zootron" up to +5 ºC. The decrease in temperature is carried out for 30 minutes. At the age of 3, 8 and 15 days, the exposure to "low temperatures" lasts 60 minutes, and at the age of 20, 25 and 30 days - 120 minutes.

The blood material was collected at the age of 7, 30, 60, and 90 days. For the research of the separate action of the "PMVAS" mineral premix and its combined action with the thermal factor on the functional state, resistance and adaptive capacities of the calves, the amount of calcium and phosphorus was studied by the spectrophotometric method, sodium and potassium by the emission photometry method, magnesium by the color reaction method with titanium yellow. The statistical processing of the obtained data was carried out by methods established for the biological field (MERKURIEVA, 1963; IVANTER & KOROSOV, 2010).

RESULTS AND DISCUSSION

The separate action of the "PMVAS" mineral premix and its combined action with the thermal factor on the body's homeostasis was established according to the indices of macroelements – calcium, phosphorus, potassium, sodium and magnesium. The obtained results regarding the content of calcium and phosphorus are presented in table 1.

The data in table 1 demonstrate that, at the calves' age of 7 days, the level of blood calcium in the animals from all groups subjected to the experiment was relatively equal and was 2.07±0.082; 2.03±0.19 and 2.04±0.04 mmol/l. At the age of 30 days, its concentration in LM was increased up to 2.19±0.02 mmol/l, in LEP - up to 2.29±0.02 mmol/l and in LEPT - up to 2.40± 0.09 mmol/l. Reported differences compared to the control group are truthful ($P<0.05$). This increase denotes the fact that the calcium value in the blood serum influenced the administration of the premix"PMVAS", which was included in the ration of calves in the experimental groups. Although the level of calcium at the age of 60 days in the blood of calves from LM increased up to 2.23±0.06 mmol/l, its level in the experimental groups was higher and constituted 2.53±0.06 in LEP and 2.58±0.12 mmol/l in LEPT ($P<0.05$). Towards the 90^{th} day, when the amount of "PMVAS" premix distributed to the calves -

decreases, the difference in the amount of calcium between the groups is reduced and its values were 2.55±0.06; 2.60±0.25 and 2.69±0.05 mmol/l, respectively for LM, LEP and LEPT.

Table 1. The values of calcium, phosphorus and their ratio in the blood of calves subjected to the separate and combined action of the food factor with the thermal one, (mmol/l).

Age of calves (days)	Groups of animals	Macroelements (mmol/l), M±m		
		Ca	P	Ca:P
7	LM	2.07±0.08	1.43±0.04	1.45±0.10
	LEP	2.03±0.19	1.41±0.06	1.44±0.11
	LEPT	2.04±0.04	1.47±0.06	1.39±0.04
30	LM	2.19±0.02	2.04±0.02	1.07±0.04
	LEP	2.29±0.02*	2.40±0.23	0.95±0.03*
	LEPT	2.40±0.09*	2.17±0.29	1.11±0.06
60	LM	2.23±0.06	2.06±0.04	1.09±0.05
	LEP	2.53±0.06*	2.07±0.07	1.22±0.09
	LEPT	2.58±0.12*	2.13±0.07	1.21±0.07
90	LM	2.55±0.06	2.11±0.15	1.21±0.05
	LEP	2.60±0.25	2.38±0.25	1.09±0.06
	LEPT	2.69±0.05	2.81±0.12*	0.96±0.04*

Note: * - differences are statistically significant between the experimental and control groups (P<0.05).
Hereinafter: LM - the control group; LEP - the experimental group in which the "PMVAS" premix was administered; LEPT - the experimental group in which the "PMVAS" premix and the thermal factor were administered.

At the same time, we mention that throughout the study period the amount of calcium in the group in which the food factor was applied conjugated with the thermal factor is higher than its amount recorded in the calves of the group in which only the food factor was applied and at the age of 7, 30, 60 and 90 days constituted 2.04±0.04; 2.40±0.09; 2.58±0.12; 2.69±0.05 mmol/l and respectively 2.03±0.19; 2.29±0.02; 2.53±0.06 and 2.60±0.25 mmol/l.

Analogous metabolic transformations were also observed when analyzing the phosphorus content in the blood serum of the calves subjected to the action of the studied factors. The addition of "PMVAS" mineral premix in the feed of calves in the experimental groups exerted a positive effect on the phosphorus content in all age periods. At the age of 90 days of the calves, the concentration of phosphorus in the blood serum in animals from LEP reached values of 2.38±0.25 mmol/l compared to 2.11±0.15 mmol/l in LM.

When analyzing the phosphorus content in the blood of calves from LEPT it is noted that the amount of phosphorus is higher compared to its value in LM and LEP during the entire experimental period, (except LEP at the age of 30 days) and, at the age of 90 days of calves, this resulted in a value of 2.81±0.12 mmol/l (P<0.05).

Other important indices that characterize the mineral properties of the food ration and the state of homeostasis of animals are the content of potassium, sodium and magnesium. The results of the separate influence of the food factor and the combined action of the food factor with the thermal one on these macroelements are presented in table 2.

The administration of the "PMVAS" mineral premix to animals from LEP of.,5 g/l of milk positively acted on the amount of potassium in the blood of calves. At the age of one month, the level of potassium in the blood serum in the LEP animals was higher (6.57±0.45 mmol/l) than its value in the LM (5.46±0,23 mmol/l) (P<0.05). At the age of 2 months, this legitimacy is also preserved in animals from LM, the amount of potassium in blood serum increased up to 6.02±0.34 mmol/l, and in LEP its level increased up to 7.04±0.26 mmol/l (P<0.05). At the age of 3 months, there was a decrease in potassium in both LM and LEP compared to the previous experimental periods and it was 4.53±0.38 mmol/l in LM and 5.10±0.14 mmol/l in LEP. The value of potassium in the blood serum of calves in LEPT throughout the study period is higher than its value in LM and LEP (P<0.05).

At the age of 7 days the amount of sodium in LM, LEP and LEPT was approximately the same and the recorded differences were not truthful. Later, at the age of 30 days, there is a tendency to increase sodium in LEP and LEPT. At the age of 60 days, its value in all three groups is practically equal and is found in the range of 126.13±0.78-126.43±1.55 mmol/l. Successively, at the calves' age of 90 days, there was a significant increase in sodium concentration in LEP (118.95±1.20 mmol/l) and in LEPT (128.77±4.11 mmol/l), compared to LM (111,61±2,55 mmol/l) (P<0.05).

The results of the K:Na ratio demonstrate an oscillatory course throughout the experimental period in LEP and LEPT, but with authentic records in LEPT at the age of 7 days of calves - increasing and at the ages of 30 and 60 days - decreasing (P< 0.05).

Table 2. The values of potassium, sodium and their ratio in the blood of calves subjected to the separate and combined action of the food factor with the thermal one, (mmol/l).

Age of calves (days)	Groups of animals	Macroelements (mmol/l), M±m		
		K	Na	K:Na
7	LM	5.59±0.27	117.19±1.03	20.96±0.32
	LEP	4.75±0.22*	117.48±1.42	24.73±1.59
	LEPT	4.71±0.16*	118.36±2.20	25.13±0.85*
30	LM	5.46±0.23	121.29±2.81	22.21±1.18
	LEP	6.57±0.45*	125.69±1.14	19.13±1.36
	LEPT	7.17±0.52*	126.43±0.64	17.63±1.31*
60	LM	6.02±0.34	126.13±1.64	20.95±1.41
	LEP	7.04±0.26*	126.13±0.78	17.92±1.73
	LEPT	7.55±0.14*	126.43±1.55	16.75±0.38*
90	LM	4.53±0.38	111.61±2.55	24.64±1.89
	LEP	5.10±0.14	118.95±1.20*	23.32±0.38
	LEPT	5.16±0.09	128.77±4.11*	24.96±0.83

Note: * - differences are statistically significant between experimental and control groups (P<0.05).

The increase in the content of the studied macroelements in the blood serum (potassium, sodium) throughout the experimental period with a true increase in potassium at the age of 30 and 60 days and of sodium at the age of 90 days denotes a physiological functioning of the organism and consequently, an increase of the adaptive capacities of the calves and the optimal maintenance of the osmotic balance of the cytosol and extracellular fluid.

Arising from the physiological importance of magnesium as it activates all known enzymes that transfer phosphate groups in metabolic reactions and the main enzymes that catalyze synthesis reactions associated with the breakdown of adenosine triphosphate and guanosine triphosphate, magnesium ions are involved in oxidative phosphorylation, enhancing the incorporation of phosphorus into its organic compounds and stimulating the formation of adenosine triphosphoric acid from nitrogen-free intermediates. The excitability of the nervous system is directly dependent on magnesium in the cattle diet. Excitability increases significantly with its lack of feed. Magnesium improves the action of pancreatic trypsin, is involved in protein synthesis and many other biochemical processes in the organism. Violation of magnesium metabolism negatively affects the physiological activity of calcium, its deficiency in the diet causes hypercalcemia, leads to an increase in calcium in the urine. At the same time, the depletion of calcium reserves in organs and tissues occurs. Magnesium is involved in the process of intermediate metabolism as a specific activator or cofactor for a number of enzyme systems. All these and other indicators equally change both from the lack and from an excess of magnesium in the diet, which caused the inclusion of this element in the present study.

During the experiments, there were significant changes in the magnesium content of the calves (Fig. 1).

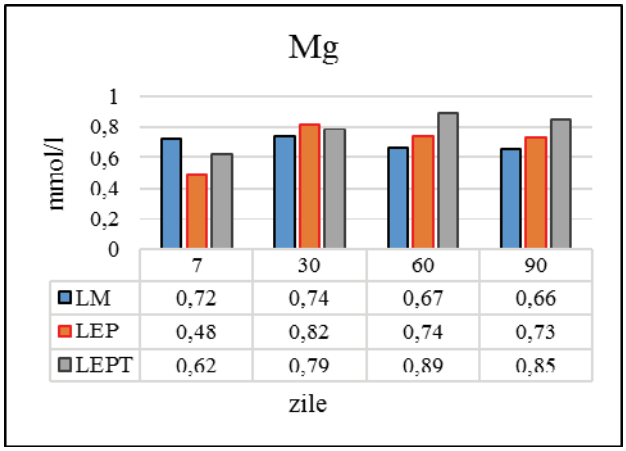

Figure 1. Magnesium content in the blood of calves subjected to the separate and conjugated action of the food factor with the thermal factor, (mmol / l).

From figure 1 it is noted that, during the study, an increase in magnesium was established in the blood of calves from LEP and LEPT in relation to LM ($P<0.05$). The comparative analysis of magnesium data between LEP and LEPT in age dynamics throughout the study period established that the magnesium content in LEPT is higher than in LEP except on the 30th day. Therefore, arising from the properties of direct correlation of magnesium with calcium and phosphorus, it is involved in fat, carbohydrate-protein metabolism, protein biosynthesis and enzyme activation.

CONCLUSIONS

Following the evaluation of the action of the studied factors, applied either separately or jointly, on the body of the calves in postnatal ontogenesis, it is possible to conclude that they ensure a more beneficial oscillatory blood level of calcium, phosphorus, potassium, sodium and magnesium. The variable nature of the values of these elements in the blood of experimental animals reflects not only their quantity, which arrives in the body through feed, but also the peculiarities of mineral metabolism. At the action of the studied factors on calves aged 30, 60 and 90 days, an increase was seen in the calcium concentration in the blood of the LEP and LEPT animals. At the same time, we mention that throughout the research period, the amount of calcium in the group in which the food factor was applied jointly with the thermal one is higher than its amount recorded in the calves of the group in which only the food factor was applied.

The "PMVAS" mineral premix in the ration of animals in the experimental groups also manifested a beneficial effect on the phosphorus content in all age periods. When analyzing the phosphorus content in the blood of calves subjected to the joint action of the studied factors, it is noted that the amount of phosphorus is higher compared to its value in the other experimental groups during the entire research period. Regarding the dynamics of the calcium:phosphorus ratio, a continuous and uniform decrease is noted towards the end of the experiments.

In this context, we mention that, upon the action of the researched factors, the amount of potassium, sodium and magnesium increased throughout the experimental period in LEP and LEPT and is higher than in LM. At the same time, the amount of potassium, sodium and magnesium in the group of animals LEPT is higher than the amount of these elements in the blood of calves from LEP.

In the context of the above, we mention that, depending on the separate or joint application of the studied factors, different results of the saline metabolism indices are obtained, with a moderate intensification of the metabolism of macroelements in age dynamics and an optimal maintenance of the osmotic balance and homeostasis in the calves' bodies.

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