THE INFLUENCE OF THE MINERAL PEMIX "PMVS" ON THE FUNCTIONAL STATE AND ADAPTIVE CAPACITIES OF CALVES IN THE POSTNATAL PERIOD

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Abstract. The main task of digestion physiology in animals is to maintain the body's homeostasis within normal limits, which is possible by determining the type of influence of the food factor on the homeostasis, development and realisation of the genetic potential of animals. The paperwork presents the mineral premix testing results made at the Institute of Physiology and Sanocreatology of the Republic of Moldova on some indices of calves' metabolism in postnatal ontogenesis for determining the parameters that can condition the resistance and adaptive capacities of animals against environmental action and acceleration of fore-stomach functionality formation. When supplementing the food ration with "PMVS", by using physiological, biochemical and microbiological methods in the dynamics of age periodization (7, 30, 60, 90 days) of calves in the experimental researches, original data was obtained referring to the functional condition, resistance and adaptive capacities of the body. The elaborated premix stimulated the functional formation of the rumen, which was manifested by the increase of fermentation processes. A positive effect of calcium, phosphorus and their ratio was found, which indicates a moderate intensification of the metabolism of macroelements. The increase of the adaptive capacities of the body and the optimal maintaining of osmotic balance of extracellular and interstitial fluid was influenced by the K^+ and Na^+ properties of premix. The microelements (Fe^{2+}, Cu^{2+} and Zn^{2+}) have influenced the composition of oxidoreduction ferments, thus contributing to anaemia prophylaxis, increased immunological reactivity and the body weight of calves. During the experimental period, changes were recorded in the metabolism of proteins and protein fractions expressed by the reduction of the content of proteins and redistribution of their fractions. Increasing the biological value of ration, by including the mineral premix "PMVS", influenced positively the cellular and humoral link of natural resistance of animals in early postnatal ontogenesis.

Keywords: mineral premix, calves, resistance, adaptation.

Rezumat. Acțiunea pemixului mineral "PMVS" asupra stării funcționale și capacităților adaptive ale vițeilor în perioada postnatală. Menținerea homeostazei organismului în limitele normei este sarcina principală a fiziologiei digestiei animalelor, care este posibilă prin determinarea naturii influenței factorului alimentar asupra homeostazei, dezvoltării și realizarea potențialului genetic al animalelor. Lucrarea prezintă rezultatele testării premixul mineral elaborat în Institutul de Fiziologie și Sanocreatologie din Republica Moldova asupra unor indici ai metabolismului vițeilor în ontogeneza postnatală întru determinarea parametrilor care pot condiționa rezistența și capacitățile adaptive ale animalelor față de acțiunea mediului ambiant și accelerarea formării funcționalității prestomacilor. La suplinirea rației alimentare cu "PMVS", prin utilizarea metodelor fiziologice, biochimice și microbiologice în dinamica periodizărilor de vârstă (7, 30, 60, 90 zile) a vițeilor în cercetările experimentale au fost obținute date originale referitoare la starea funcțională, rezistența și capacitățile adaptive ale organismului. Premixul elaborat a stimulat formarea funcțională a rumenului, care s-a manifestat prin creșterea proceselor de fermentație. S-a constatat un efect pozitiv al calciului, fosforului și raportului lor, ceea ce denotă o intensificare moderată a metabolismului macroelementelor. Majorarea capacităților adaptive ale organismului și menținerea optimală a echilibrului osmotic a lichidului interstițial și extracelular a fost influențată de proprietățile K^+ și Na^+ din premix. Microelementele (Fe^{2+}, Cu^{2+} și Zn^{2+}) au influențat componența fermenților oxidoreducători, astfel, contribuind la profilaxia anemiei, sporirea reactivității imunologice și creșterea masei corporale a vițeilor. Pe parcursul perioadei experimentale s-au înregistrat schimbări în metabolismul proteinelor și a fracțiilor proteice exprimate prin reducerea conținutului de proteine și redistribuirea fracțiilor acestora. Ridicarea valorii biologice a rației, prin includerea premixului mineral "PMVS", a acționat pozitiv asupra verigii celulare și umorale a rezistenței naturale a animalelor în ontogeneza postnatală timpurie.

Cuvinte cheie: premix mineral, viței, rezistență, adaptare.

INTRODUCTION

The functional condition of the body and the productivity of animals are significantly influenced by the biological value and the balance of food rations. Special requirements are assigned to rations intended for calves in the early postnatal period. The research conducted on animals in the first months of life has shown that a large number of diseases and functional disorders of the body are recorded during this period (USDA, 1997; JEGOU et. al., 2006; GONZÁLEZ MARTÍN & ELVIRA PARTIDA, 2011).

It has been demonstrated (SIDOROV & GUSHCHIN, 1984; FURDUI et. al., 1992; STRUTINSCHI, 1997) that about 70% of the herd of calves manifest functional disorders of the gastrointestinal tract. HEINRICHS & RADOSTITS (2001) stated that in the first 3 months after birth 75% of the calves' deaths are caused by disorders of the gastrointestinal tract. The main reason for such disorders is the functional immaturity of calves which is determined by the lack of balanced fodder and the influence of technological factors on the weaned cows, as well as on the calves in the first days of life (TELTSOV & ILYIN, 1993; MARIE-VINCIANE, 2008).

The biochemical analysis of the calves' blood showed that a considerable number of macro - and microelements are below the recommended standards or at their lower limits (DRONOV, 2000). It is obvious that such condition strains the systems that provide the internal homeostasis of the body, leading to overload, dysfunction of some

systems and to the appearance of various diseases (LORENZ et. al., 2011). In this case the basic ration of calves does not ensure the normal state of homeostasis and can be classified as a moderate stress factor. As a result, functional disorders and diseases may occur and their correction requires the development of procedures that would normalize the homeostasis. Of particular interest are the problems related to acceleration of the functional formation of the forestomaches, in particular of rumen until the animal reaches the mature level. This makes it possible to give the animals cheap and varied fodder and to teach them to use coarse and bulky fodders in large quantities that are economically convenient.

MATERIAL AND METHODS

The scientific investigations were carried out on a herd of black-spotted calves, selected according to the analogue principle, taking into account the breed, age, sex and weight.

The mineral premix "PMVS", produced at the Institute of Physiology and Sanocreatology, containing cobalt carbonate, copper sulphate, iron sulphate, potassium iodate, manganese sulphate, zinc sulphate, sodium humate, calcium phosphate and excipient in variable concentrations, was tested to correct the saline metabolism, to normalize the general metabolism and to increase the adaptive and productive capacities of animals. The quantity of mineral substances in the composition of premix was calculated emerging from the existing rules, the content of mineral substances in the blood of animals and their estimated value in fodder. This concentration, depending on the active properties of the integrated compounds, constituted various values in the range from 0.1 mg up to 100.0 g.

The experiments were carried out according to the periodization growth of calves developed by the Institute of Physiology and Sanocreatology, which included the arc of time from the 7^{th} to the 90^{th} day of postnatal ontogenesis, a period in which the adaptive capacities of calves are expected to increase.

The animals of both groups included in the experiments during the research period were under equal maintenance conditions and received the same basic food ration, which was composed of hay, haylage, silage and concentrated fodder according to existing regulations, and was consumed by calves in unlimited quantities. At the same time, each calf from both groups, during the research period, consumed 300 litres of whole milk.

The difference between the feed rations was that the animals of the additional experimental group received the mineral premix "PMVS" to the basic ration in a quantity of 1.5 g per 1 litre of consumed milk.

The blood samples were collected at the age of 7, 30, 60, and 90 days of postnatal ontogenesis. The samples of ruminal fluid were collected at 30, 60 and 90 days. In the process of experimentation, the physiological, biochemical and microbiological methods of research were used.

In order to determine the effect of the mineral premix "PMVS" on the functional condition, resistance and adaptive capacities of calves, the following physiological indices were studied: *in the rumen* - the quantity of volatile fatty acids (VFA) through the method of titration, the quantity of aerobic bacteria through the method of planting, quantity of anaerobic bacteria through the Hangheit method changing Taracanov, quantity of amylolitic bacteria through the roll-tube culture method and the quantity of lactic acid baccilus through the Rogosa-Sharpe method in changing Taracanov; *in blood* - the total proteins were determined by the refractometric method, the protein fractions through the turbidimetric method (nephelometric), the urea was determined colometrically thought the method of decomposition of urea by urease in the reaction with the Nessler's reagent, the quantity of Ca and P through the spectrophotometric method, Na and K through the photometry method of emission, Mg through the method of colour reaction with yellow of titanium in changing of Petruhin, quantity of Fe, Cu, and Zn though the photoelectric colorimetric method. The glucose in the blood was determined after the colour reaction with ortho-toluidine, phagocytosis under Gostev and the bactericidal activity was determined using the culture of staphylococcus aureus strain no. 209. The statistical processing of the obtained cipher material was carried out through methods established for the biological field.

RESULTS AND DISCUSSIONS

The influence of the mineral premix "PMVS" on the dynamics of fermentation processes according to the tested phases in different age periods is shown in table 1.

Table 1. Evolution of the VFA quantity in the ruminal content in calves subjected to the influence of the mineral premix "PMVS" in postnatal ontogenesis.

Group of animals	**Volatile fatty acids content (ml/l), M±m**		
	30 days	60 days	90 days
Control Group - CG	7.07±0.47	7.07±0.41	10.40±1.25
Experimental Group - EG	7.50±0.60	10.27±0.57*	11.53±0.15

Note: * - the differences are statistically significant between the experimental and the control groups ($P<0.05$).
Here and further: CG - Control Group; EG - Experimental Group.

So, at the age of 7 days the rumen practically does not participate in the processes of digestion, therefore there was no opportunity to record the indices of biocenosis and of fermentation processes at the beginning of the experiment. At the age of 30 days an obvious tendency of increasing the fermentation processes was recorded only in EG. Such a picture of fermentation processes testifies us that in the first days of life the animals were sensitive to the mineral premix ”PMVS”. This condition was confirmed by the studied indices at the age of 60 days. In the CG where the calves used the basic food ration without adding the “PMVS”, the concentration of VFA did not change in comparison to the previous period and it was 7.07±0.41 ml/l. Feeding with the mineral premix in the quantity of 1.5g per 1 litre of milk has ensured a significant increase ($p<0.05$) of VFA concentration up to 10.27±0.57 ml/l in EG. At the age of 90 days the concentration of VFA between the groups is reduced. It was therefore found that this is conditioned by the fact that towards the end of this period the calves stopped receiving milk, including the mineral premix. The animals of the CG the had an increased VFA concentration up to 10.40±1.25 ml/l, and in EG - up to 11.53±0.15 ml/l.

The nature of fermentation processes in the ruminal cavity is largely determined by the vital activity and variety of composition of rumen biocenosis. The composition of rumen biocenosis according to the experimental periods is presented in table 2, in decimal logarithms.

Table 2. Quantity of microorganisms in 1 ml of ruminal content in calves subjected to the action of the mineral premix “PMVS” in postnatal ontogenesis.

Age of calves (days)	Group of animals	Direct calculation (log cfu/ml), M±m	Agar-overlay Peptone		Lactic acid bacilli, (log), M±m	Amylolytic bacteria, (log), M±m
			Aerobic bacteria, (log) M±m	Anaerobic bacteria, (log), M±m		
30	CG	2.25±0.30	1.90±0.10	1.81±0.05	1.93±0.11	1.83±0.06
	EG	2.33±0.35	1.96±0.13	1.77±0.02	1.87±0.08	1.91±0.10
60	CG	2.31±0.34	1.81±0.05	1.86±0.08	1.60±0.03	1.83±0.06
	EG	2.34±0.35	1.88±0.09	1.73±0.02	1.96±0.11*	1.82±0.05
90	CG	2.21±0.28	1.84±0.06	1.81±0.04	1.62±0.04	1.80±0.04
	EG	2.29±0.32	1.87±0.08	1.98±0.14	1.88±0.07*	1.64±0.05*

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

From the data of table 2 the microbial population of rumen is essentially distinguished in both groups, a greater quantity of it was recorded in EG. A tendency of increasing the quantity of aerobic bacteria and reducing the anaerobic ones, except for the 90 days, was found in the latter. Such a nature of the biocenosis is determined by the more frequent consumption of fodder, which predetermined the increase of aerobic bacteria and the reduction of anaerobic ones. Regarding the lactic acid bacillus, a preponderance thereof (1.93±0.11 log) was noticed in the CG compared to the EG (1.87±0.08 log) only at the age of 30-days of the calves. At the age of 60 days, the quantity of lactic acid bacillus in EG increased up to 1.96±0.11 log ($P<0.05$), in comparison to 1.6±0.03 log in CG. At the age of 90 days this increase was maintained. The quantity of lactic acid bacillus in CG was of 1.62±0.04 log, while in the EG the amount was higher and constituted 1.88±0.07 log ($P<0.05$).

The quantity of amylolytic bacteria tended to increase in the EG (1.91±0.10 log) in comparison to the CG (1.83±0.06 log) at the age of 30 days. In later periods of the experiments this index tended to decrease in the experimental variant II (60 days) and varied significantly in variant III (90 days). Their value at 60 days for CG was 1.83±0.06 log and for EG - 1.82±0.05 log. At 90 days the quantity of amylolytic bacteria in CG was 1.80±0.04 log with a decrease to 1.64±0.05 log ($P<0.05$) in EG.

So, the prepared mineral premix “PMVS” had a stimulating influence on the functional formation of the rumen, which manifested itself in the significant increase of fermentation processes in the rumen of animals from EG. The large fermentation processes are determined by the high biochemical activity of the ruminal biocenosis of experimental animals.

The action of the mineral premix “PMVS” investigated on the homeostasis of the body was studied according to the indices of macro-elements (calcium, phosphorus, potassium, sodium, magnesium) and indices of microelements (iron, copper and zinc) (Table 3).

Table 3. Indices of calcium and phosphorus in the blood of calves subjected to the influence of the mineral premix ”PMVS” in postnatal ontogenesis.

Age of calves (days)	Group of animals	**Macroelements (mmol/l), M±m**		
		Ca	P	Ca:P
7	CG	2.07±0.08	1.43±0.04	1.45±0.10
	EG	2.03±0.19	1.41±0.06	1.44±0.11
30	CG	2.19±0.02	2.04±0.02	1.07±0.04
	EG	2.29±0.02*	2.40±0.23	0.95±0.03*
60	CG	2.23±0.06	2.06±0.04	1.09±0.05
	EG	2.53±0.06*	2.07±0.07	1.22±0.09
90	CG	2.55±0.06	2.11±0.15	1.21±0.05
	EG	2.60±0.25	2.38±0.25	1.09±0.06

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

In the conditions of industrial production of cattle in the blood a deficit of mineral substances was often recorded. Calcium deficiency, as is known, leads to rickets and osteomalacia (NAZDRACHEVA, 2004; TREBUKHOV, 2018) it also causes gastrointestinal tract dysfunction and respiratory diseases because of a general weakened immune system in the body (BATRAKOV et. al., 2017). In order to normalize the formation of the skeleton, to increase the vascular permeability and to optimize the functionality of the nervous tissue, of the skeletal and cardiac muscles, calcium phosphate was included in the composition of premix. At the same time, Ca and P participate in the activation of some hormones and ferments (VOLKOV et. al., 2010; CAPSAMUN et. al., 2019). As shown in table 3, at the beginning of experiments the level of Ca in the animals of both groups was approximately equal and it was 2.07±0.82 and 2.03±0.19 mmol/l. At the age of 30 days the Ca concentration in the CG increased up to 2.19±0.02 mmol/l. In the EG the Ca increased up to 2.29±0.02 mmol/l. The difference recorded in comparison to the CG is significant ($P<0.05$). This increase indicates that the level of Ca in the blood serum was influenced by the mineral premix that was included in the ration of animals of the EG. Although the level of Ca at the age of 60 days in the blood serum of the calves of the CG increased up to 2.23±0.06 mmol/l, its level in the EG was significantly higher ($P<0.05$) and constituted 2.53±0..06 mmol/l. Towards the 90th day when the amount of milk distributed to the calves decreases (according to the scheme of conducting experiments, the distribution of premix also decreases) the quantity of calcium in both groups was practically equal and it constituted 2.55±0.06 mmol/l and 2.60±0.25 mmol/l for the control and experimental group.

Analogue functional transformations were also noticed in phosphorus insufficiency too. The addition of the mineral premix "PMVS" in the ration of animals of the EG had a positive effect on the content of phosphorus at all age periods. At the end of experiments, when the calves were 90 days old, the P concentration in the blood serum of the EG increased up to 2.38±0.25 mmol/l compared to 2.11±0.15 mmol/l in the CG.

At the age of 30, 60 and 90 days of calves of the EG after supplementing the food ration with the mineral premix "PMVS", the concentration of Ca in blood increases; a positive effect was found on the content of P and the ratio of Ca decreases P (Ca:P) which denotes a moderate intensification of macro-elements metabolism in age dynamics, and implicitly a functional optimization of the gastrointestinal and respiratory tract. An important index characterizing the biological capacities of the food ration and adaptive capacities of animals is the content of potassium (Table 4).

Table 4. Indices of potassium, sodium and magnesium in the blood of calves subjected to the action of the mineral premix "PMVS" in postnatal ontogenesis.

Age of calves (days)	Group of animals	Macroelements (mmol/l), M±m			
		K	Na	K:Na	Mg
7	CG	5.59±0.27	117.19±1.03	20.96±0.32	0.72±0.15
	EG	4.75±0.22*	117.48±1.42	24.73±1.59	0.48±0.01
30	CG	5.46±0.23	121.29±2.81	22.21±1.18	0.74±0.03
	EG	6.57±0.45*	125.69±1.14	19.13±1.36	0.82±0.05
60	CG	6.02±0.34	126.13±1.64	20.95±1.41	0.67±0.04
	EG	7.04±0.26*	126.13±0.78	17.92±1.73	0.74±0.03
90	CG	4.53±0.38	111.61±2.55	24.64±1.89	0.66±0.04
	EG	5.10±0.14	118.95±1.20*	23.32±0.38	0.73±0.03

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

It is known that K is important in the functioning of neurons and influences the osmotic balance between cells and interstitial fluid with a distribution throughout the body by the so-called Na^+/K^+-ATP (KOLESNICHENKO & KULINSKY, 2004). At stressful actions, K is removed from the animal's body as they sweat almost 10 times harder than when they are maintained in comfortable conditions. Therefore, the high content of K in the blood of animals demonstrates the increase of adaptive capacities of the body (KOLESNICHENKO & KULINSKY, 2004). The administration of the mineral premix "PMVS" to the calves of the EG of 1.5 g/l of milk had a positive influence on the quantity of K in the blood serum of animals. At the age of 30 days its level in the blood serum in the animals of the EG was 6.57±0.45 mmol/l, while in the animals of the CG it was 5.46±0.23 mmol/l ($P<0.05$). At the age of 60 days this rule was maintained. When the quantity of K in blood serum of animals of the CG increased up to 6.02±0.34 mmol/l, its level reached 7.04±0.26 mmol/l in the EG and was significantly higher ($P<0.05$). At the age of 90 days, the level of K in both groups decreased to 4.53±0.38 mmol/l in the CG and 5.10±0.14 mmol/l in the EG, and the difference between the groups was not significant.

The Na maintains the osmotic pressure of the extracellular fluid, entering the composition of the buffering systems. In order to increase the natural resistance, sodium humate was also introduced in the composition of the premix. Throughout the research period, the concentration of Na in the CG and EG was approximately the same and the noticed differences were not significant. An exception was recorded at the age of 90 days where the concentration of Na in the EG (118.95±1.20 mmol/l) was significantly higher ($P<0.05$) in comparison to the CG (111.61±2.55 mmol/l).

Approximately the same changes were noticed in the content of Mg in calves. However, a significant increase of the level in comparison to the control group was not recorded.

The increase of the content of macroelements in blood serum (K, Na, Mg) during the entire experimental period, with a significant increase of K at the age of 30 and 60 days and of Na at the age of 90 days, indicates an increase of the adaptive capacities of the body and optimal maintenance of osmotic balance of the interstitial and extracellular fluid. In the experiments, the evolution of the concentration of important microelements for the body was also studied (Fig. 1).

Iron is a component of oxidoreductive ferments (KOVALEV, 1999). It exerts a major importance in the tissue nutrition and respiration and thus contributed to the growth of live weight and preservation of the herd of calves (ZAVALISHINA et. al., 2011). In normal values, iron participates in the prophylaxis of anaemia, increases the immunological reactivity of animals (USACHEV & STRELTSOV, 2019). Zinc participates in many metabolic reactions, influences the activity of fore stomachs' microflora, regulates the reproductive function, and participates in osteogenesis (CHOMAEV et. al., 2014; DEREZINA & USHAKOVA, 2017). Taking into account that copper participates in haemopoiesis, in the activity of the rumen's microflora, in the development of the skeleton, in the increase of productivity and has an influence on the functional condition of the endocrine and nervous systems (KUCHINSKY, 2007), copper sulphate was included in the composition of the premix.

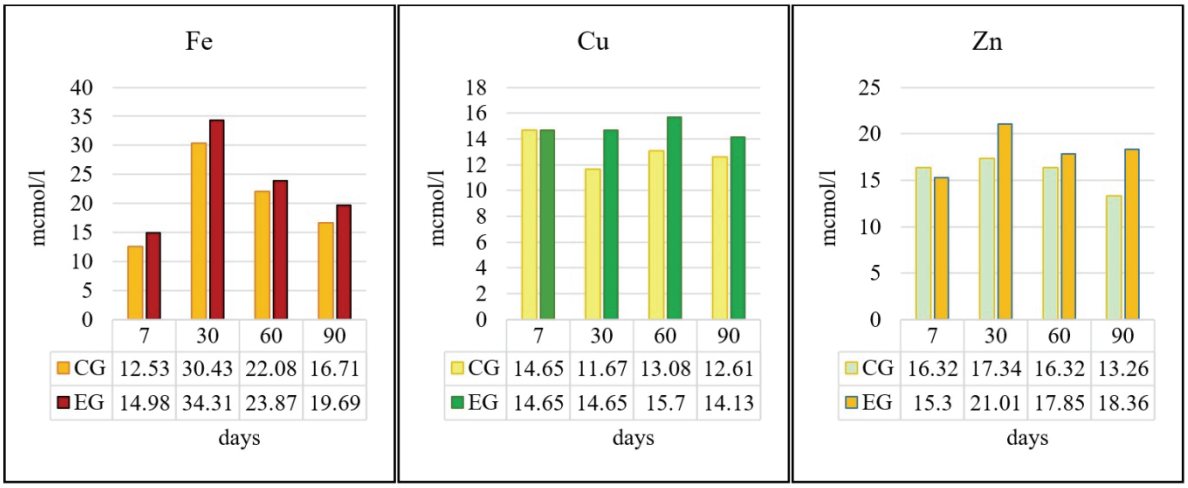

Figure 1. Indices of iron, copper and zinc in the blood of calves subjected to the influence of the mineral premix "PMVS" in postnatal ontogenesis.

From the data of Fig. 1, it resulted that the quantity of iron in the blood plasma is an important indicator characterizing the biological value of rations and the effectiveness of prophylaxis of iron deficiency anaemia. The analysis of the content of iron in experimental animals demonstrated a significant increase of the level of iron in the blood plasma of calves of both groups at the age of 30 days. In the subsequent periods of the experiments (60 and 90 days) the quantity of iron in both groups is reduced. Although, in time, its quantity in the blood plasma tends to decrease, higher values were recorded in the EG. Therefore, at the age of 30 days the quantity of iron in the EG was 34.31±1.82 mcmol/l, while in the CG 30.43±2.74 mcmol/l. At the age of 60 days the iron level in the CG decreased to 22.08±2.60 mcmol/l and in the EG to 23.87±1.58 mcmol/l. An analogue tendency was also maintained at the age of 90 days, establishing values of 16.71±1.15 mcmol/l and 19.69±1.03 mcmol/l, accordingly to CG and EG ($P<0.05$). The changing nature of the level of iron in the blood plasma of experimental animals reflected not only the amount of iron that comes by ration, but also peculiarities of its metabolism.

The insufficiency of copper in the rations of animals conditions the reduction of productivity, bone degeneration, disorder of hair creatinization and deregulation of the functional condition of haematopoietic organs (MASHKINA & STEPANENKO, 2017; SMOLIN, 2018). Throughout the research period the copper level in the experimental group was higher in comparison to that in the control group, which at 60 days was 15.70±0.87 mcmol/l ($P<0.05$).

The level of zinc in the blood serum (Fig. 1) of animals of both groups oscillated and at the age of 60 and 90 days the zinc values were significantly modified ($P<0.05$).

So, from the data of fig. 1 it can be concluded that during the entire experimental period the quantity of microelements Fe, Cu and Zn in EG is higher compared to its values in CG. At the same time, the mineral premix ŢPMVS" had a positive effect on the composition of oxidoreductive ferments, exerting a major importance on the tissue nutrition and respiration and thus contributed to the prophylaxis of anaemia, increased the immunological reactivity of calves, increased the live weight of animals by fully preserving the herd of calves.

In this context, the conducted research have shown that the use by calves of the mineral premix "PMVS" ensures a more optimal level of calcium, phosphorus, potassium, sodium, magnesium, copper iron and zinc in the blood.

Another research was applied to the protein metabolism indices, which is an important criterion demonstrating the biological value of the rations consumed, the functional state of the animals and the metabolic processes occurring

in the body (KONDRAKHIN et. al., 2004). The results of researches of the total protein and protein fractions in the blood of calves are presented in table 5.

The data in table 5 demonstrates that the influence of the mineral premix ȚPMVS" showed an important action on protein metabolism in general and on protein fractions in particular. At the same time, the studied mineral premix had an uneven influence on the protein metabolism indices analysed in dynamics according to the tested ages.

Table 5. The content of total protein and protein fractions in the blood of calves subjected to the action of the mineral premix ȚPMVS" in postnatal ontogenesis.

Age of calves (days)	Group of animals	Total Protein, (g/%), M±m	Protein fractions (%), M±m			
			albumins	α-globulins	β-globulins	γ-globulins
7	CG	6.97±0.57	53.22±5.21	6.75±1.62	11.22±0.61	22.40±2.41
	EG	6.16±0.59	65.94±7.03	5.79±1.19	7.91±0.85*	14.57±2.12*
30	CG	6.49±0.08	50.66±0.72	7.30±1.02	9.21±0.71	25.54±1.74
	EG	5.70±0.09*	57.69±1.93*	6.72±1.04	9.76±0.84	19.12±2.55
60	CG	6.37±0.05	41.92±3.09	7.16±2.58	23.28±1.12	20.73±1.96
	EG	5.88±0.27	43.06±4.85	6.36±1.38	21.62±2.45	22.60±3.71
90	CG	7.34±0.38	35.53±6.83	5.81±0.85	24.32±3.01	28.54±4.23
	EG	7.25±0.17	34.58±4.57	6.22±0.80	23.44±2.27	29.56±3.82

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

The albumins perform the function of transporting mainly the nutritive substances in the body (KONDRAKHIN et. al., 2004). The globulins are proteins responsible for the immunological status of the animal body (KLYAPNEV, 2019). In this context it is necessary to mention that in both groups of animals with age periods, the albumins decrease and the fraction of globulins increases.

At the age of 30 days the quantity of albumins in the CG in comparison to the previous period decreased from 53.22±5.21% to 50.66±0.72%. In the EG the albumins decreased from 65.94±7.03% to 57.6.69±1.93% (P<0.05). The percentage of albumins in the EG was significantly higher (P<0.05) in comparison to the CG.

A more essential growth of globulins during this period was found in the EG. At the beginning of the experiments the ratio of albumins to globulins was 2.16, then, at the age of 30 days it was equal to 1.34. The total quantity of globulins has raised due to the increase of the γ-globulin fraction from 14.57±2.12 up to 19.12±2.55%.

The highest concentration of γ-globulins was found in the CG at the age of 7 days. This high level of γ-globulin concentration in the control group was probably determined by the type of nutrition and conditions of maintenance of animals before beginning the experiments, as at the age of 7 days the level of γ-globulin was 22..40±2.41% and was higher than in the EG.

The nature of changes of protein fractions noted at the age of 30 days was registered at the age of 60 days too. At this age, a more obvious influence of the mineral premix was detected. The albumin level continued to decrease and in the CG it was 41.92±3.09% and in the EG it was 43.06±4.85%.

An obvious influence of "PMVS" was recorded in the case of γ-globulins. In the CG they decreased from 25.54±1.74% (at 30 days) to 20.73±1.96% at the age of 60 days. At the same time, the concentration of γ-globulins increased from 19.12±2.55% up to 22.60±3.71% in the EG.

An analogue structure of changes in protein fractions depending on the age of calves was preserved at the age of 90 days of postnatal ontogenesis too. At this age, as in the previous periods, a higher level of γ-globulins was reported in the EG and it was 29.56±3.82% in comparison to 28.54±4.23% in the CG.

So, the data obtained allows to conclude that the mineral premix had a positive effect on the percentage content of γ-globulins, globulins that characterize the immunological condition of animal's body (KONDRAKHIN et. al., 2004).

Indices of natural resistance demonstrate the health condition of the animal and characterize the stability of the body to the action of various environmental factors and pathogenic agents. Particular relevance is given to this problem when the calves are reared in specialized breeding farms where a large number of animals is recorded (PLYASHCHENKO & SIDOROV, 1987). In such conditions a variety of technological factors have a negative impact on calves (KUZNETSOV & MIFTAKHUTDINOV, 2021). This problem determines that many researchers use indices of cellular and humoral immunity as indices of assessment and characterization of the adaptive capacities of animals (KLYAPNEV, 2019).

The introduction of the mineral premix "PMVS" in the ration of calves increased the biological value of the feed ration, which is beneficial to the examined indices of natural resistance of animals. Fig. 2 includes experimental data demonstrating the action of the experimented mineral premix "PMVS" on the phagocyte activity of animals.

The level of phagocyte activity in calves at the age of 7 days in both groups was sufficiently high and it was 62.00±2.00% and 55.33±3.07%. This fact demonstrates that at the onset of experiments the colostrum immunity is quite high in all groups of animals. At the age of 30 days, phagocyte activity in the CG has decreased in comparison to its initial level to 54.67±1.34%. In the calves of the EG the phagocyte activity increased from 55.33±3.07% up to 57.33±4.38%. The most obvious influence of the experienced "PMVS" on phagocyte activity was recorded in the calves with the age of 60 days. In the EG it was 38.67±0.67% and in the CG - 35.33±1.77%. An analogue connection was also

recorded in more mature calves. At the age of 90 days the calves of the EG, by phagocyte activity, overcame the calves of the CG.

If the indices of phagocyte activity characterize the cellular link of natural resistance, then bactericidal activity allows to assess the humoral link of the immune system (Table 6).

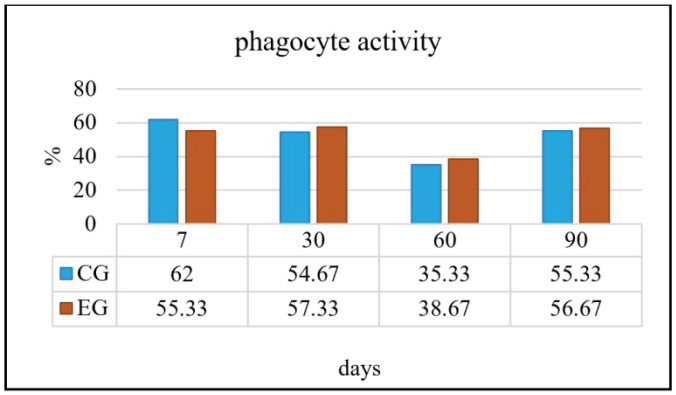

Figure 2. Phagocyte activity in the blood of calves subjected to the action of the mineral premix "PMVS" in postnatal ontogenesis.

Table 6. Bactericidal activity in the blood of calves subjected to the action of the mineral premix "PMVS" in postnatal ontogenesis.

Age of calves (days)	**Group of animals**	**Bactericidal activity (%), M±m**		
		1 hour	3 hours	6 hours
7	CG	80.00±3.00	79.33±4.06	81.33±1.34
	EG	71.67±3.76	75.33±6.65	84.67±4.38
30	CG	83.00±1.00	88.00±2.65	92.00±2.74
	EG	89.00±1.53*	89.67±1.45	94.33±0.88
60	CG	89.33±4.67	87.67±1.45	89.33±4.67
	EG	90.33±0.33	90.33±0.33	90.33±0.33
90	CG	66.00±3.22	76.67±1.34	80.33±2.61
	EG	68.67±0.67	71.00±0.58*	73.33±0.88*

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

The data shown in table 6 demonstrates that the inclusion of mineral premix in the ration had a beneficial effect on bactericidal activity. Almost at all ages of research, at the exposure of 1, 3, and 6 hours, the bactericidal activity was higher in the EG. At the age of 30 days in the EG it was significantly higher (P<0.05) in comparison to the CG and it was 89.00±1.53% compared to 83.0±1.00%. At the exposure of 3 and 6 hours there was a significant increase of bactericidal activity in the EG, where it was, respectively, 71.00±0.58 and 73.33±0.88% compared to 76.67±1.34 and 80.33±2.61% in the CG (P<0.05).

The obtained experimental data testified the fact that increasing the biological value of the ration by including the created mineral premix had a positive impact on the cellular and humoral link of natural resistance of animals in postnatal ontogenesis.

One of the important indices for assessing the influence of the mineral premix "PMVS" on the functional state, adaptive capacities and resistance of the body is the data about productivity of animals according to experimental periods. The productivity dynamics of experimental animals in age periods is shown in table 7.

Table 7. The dynamics of weight in calves subjected to the influence of the mineral premix "PMVS" in postnatal ontogenesis.

Group of animals	**Weight (kg), M±m**			
	7 days	30 days	60 days	90 days
CG	32.77±0.86	47.38±1.37	67.82±1.99	90.90±1.11
EG	32.23±0.70	47.32±1.63	73.20±1.42*	96.20±1.35*

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

From the data of table 7 it resulted that feeding the calves with the mineral premix "PMVS" in postnatal ontogenesis influenced the productivity of calves. At the beginning of experiments, when the groups of calves were created according to the "analogue" principle, the average weight of calves in the CG was 32.77±0.86 kg and 32.23±0.70 kg in the EC. The weight of animals was within the limits of standards provided and recommended in the methodical recommendations for making experiments on calves.

Although at the age of 30 days the mineral premix had a positive influence on the examined biochemical indices, on productivity it did not manifest particular changes. The average weight of the calves was 47.38±1.37 in the CG and 47.32±1.63 kg in the EC. This fact demonstrates that the positive deviations in the biochemical indices of

experimental animals were sufficient only for increasing the adaptive capacities and functional stabilization of the body, but not for increasing the body weight. Feeding calves with the mineral premix "PMVS" in the first experimental period (from 7 up to 30 days) is insufficient for creating essential deviations in productivity.

At the age of 60 days the body weight of the calves in the EC was 73.2±2.42 kg compared to 67.82±1.99 kg in the CG, and it was 1.08 times greater($P<0.05$). The data provided shows that at the age of 60 days the mineral premix acted positively on the productivity of animals. This tendency was also maintained at the age of 90 days too. The body weight of calves in the CG during this period was 90.9±1.11 kg and 96.2±1.35 kg in the EC ($P<0.05$). Overall, throughout the research period (from 7 up to 90 days) the diurnal growth of the body weight in the EC was 770 g and it was higher than in the CG which was 700 g.

CONCLUSIONS

1. The produced mineral premix "PMVS" had a stimulating influence on the functional formation of rumen, which was manifested by the significant increase of the fermentation processes in the rumen of animals from the EG, and the nature of the fermentation processes in the ruminal cavity, to a large extent, is determined by the vital activity and by the variety of the rumen biocenosis composition.

2. At the age of 30, 60 and 90 days of calves from the EG after supplementing the food ration with the mineral premix "PMVS", the concentration of Ca in blood was increased; a positive effect on the content of P was found and the ratio of Ca: P decreased, fact which denotes a moderate intensification of the macroelements' metabolism in age dynamics and implicitly the functional optimization of the respiratory and gastrointestinal tract.

3. The increase of the content of studied microelements in blood serum (potassium, sodium, magnesium) during the entire experimental period, with a significant increase of K at the age of 30 and 60 days and of Na at the age of 90 days, indicated an increase of adaptive capacities of the body and optimal maintenance of osmotic balance of the interstitial and extracellular fluid.

4. During the entire experimental period the quantity of microelements Fe, Cu and Zn in the EG is higher in comparison to its values in CG. At the same time, the mineral premix "PMVS" had a positive effect on the composition of oxidoreductive ferments, exerting a major importance on the tissue nutrition and respiration and thus contributed to the prophylaxis of anaemia, increased the immunological reactivity of calves, increased the live weight of animals by fully preserving the herd of calves.

5. During the experimental period changes were recorded in the metabolism of proteins and protein fractions expressed by the reduction of the protein content and redistribution of their fractions, manifested by the reduction of the quantity of albumins and increase of the total quantity of globulins. In particular, the γ-globulins (globulins which characterize the immunological condition of the animal body), in the CG from the age of 7 days up to 90 days the has increased by 1.27 times in comparison to those from the EG, where an increase of 2.02 was recorded.

6. The increase of the biological value of the ration, by including the mineral premix "PMVS", acted positively on the cellular and humoral link of natural resistance of animals in early postnatal ontogenesis. Basically, at all research ages, the bactericidal activity at the exposure of 1, 3 and 6 hours was higher in the EG. At the age of 30 days in the EG it has increased ($P<0.05$) in comparison to the CG and it was 89.00±1.53% compared to 83.0±1.00%.

7. The obtained results demonstrate that the produced mineral premix, distributed to animals in a quantity of 1.5 g/l of milk, show a positive effect on the productivity of animals in postnatal ontogenesis. Thus, the diurnal increase in calves' weight in EG was 770g and was 70g higher than in CG which was 700g.

8. Maintaining the homeostasis of the body within the limits of the standards is the main task of the physiology of animal digestion, and determining the nature of influence of the food factor on the homeostasis and development of calves in early ontogenesis would allow to create optimal ecological conditions that can facilitate the acceleration of the functional maturation of vital organs and systems, improve the adaptive capacities and resistance of the body to the influence of stress factors and realizing the genetic potential of animals.

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