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**THE PECULIARITIES OF THE ADAPTIVE  
CAPACITIES AND RESISTANCE OF CARP LARVAE  
AND CALVES DEPENDING ON THE INFLUENCE OF  
ENVIRONMENTAL FACTORS**

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## CONCEPTUAL RESEARCH REFERENCES

**The actuality and importance of the subject matter.** The environment is constantly changing, its components are diverse, so all organisms must constantly adapt to new conditions in order to survive and reproduce. These stressors act separately or in combination on animals, and their action is manifested itself in profound changes in the various physiological processes that take place in the body. The organism is constantly adapting to environmental conditions through metabolic and physiological responses that produce changes at various structural levels of the vital systems and the organism as a whole [2; 3; 4; 7; 8; 9; 10].

This need for adaptation is more evident in industrial conditions of animal husbandry, because in most cases the parameters of the microclimate are not respected or do not correspond to the physiological peculiarities of the organism of the animals kept, and thus the principle of alternation between moderate stressful and comfortogenic periods, which exists in the natural environment of animal husbandry, is violated. Lack of the principle of alternation sooner or later leads to premature degradation of vital organ systems. In connection with this, in order to maintain and raise the physiological capacities of the organism it is necessary to apply consecutively periods of maintenance of animals under moderate stressogenic conditions and comfortable periods [6; 14; 17; 18].

At present, it becomes clear, that at the present stage of development of biological sciences, in particular, of the sciences dealing with the breeding and maintenance of productive animals extensive research is needed to solve the problems caused by environmental factors of a stressogenic intensity and to predict the course of physiological processes in the organism to their action. The need for effective health counselling and the development of ways to mitigate and correct the harmful consequences of stressors also arises from the imperative to address the problem of stress in animals with different capacities to maintain a constant internal temperature, such as homeotherms (mammals) and poikilotherms (fish) [1; 21; 22].

The perspective of this research will provide opportunities to reflect the individual characteristics of poikilothermic and homeothermic animals through the lens of the variability of organismal physiology based on general developmental principles. Moreover, the research will certainly contribute to the increase of production in aquaculture of the Republic of Moldova, which currently accounts for 25% of the value of all fish production and fish products consumed in the country, as well as to the increase of productivity, safety and harmlessness of food products, obtained from the branch of cattle breeding and exploitation, traditional sectors for our country. Therefore, to create optimal conditions for the manifestation of the physiological

potential of the phenotype of the species and the individual capabilities of the animal organism, acquired in epigenetics, as well as, for the proper maintenance of biodiversity it is necessary to practice sustainable activities and to develop and implement mechanisms for the conservation of the gene pool and functional maintenance of animal reproduction.

Research will provide scientists and practitioners not only with an overall picture of physiological variation in response of poikilothermic and homeothermic organisms to the action of environmental factors of stressful intensity, but also with a picture based on authentic evidence and scientific analysis. This will make it possible to determine the frequency and parameters of application of environmental factors of moderate stressogenic intensity in the early postnatal period with the aim of raising the organism's adaptive and defensive capacities, which will be manifested throughout life.

**Research purpose.** To evaluate the separate and combined action of abiotic environmental factors of moderate stressogenic intensity on the vitality and morphofunctional status of carp larvae (*Cyprinus carpio*) and calves in early postnatal ontogeny.

**Research objectives.**

1. To investigate the action of different low temperature regimes of moderate stressogenic intensity on the morphofunctional capacities and vitality of carp larvae (*Cyprinus carpio*).

2. To evaluate the action of low temperature of moderate stressogenic intensity on the physiological state, non-specific resistance and adaptive capacities of the organism of calves in early postnatal ontogeny.

3. To evaluate the action of low temperature of moderate stressogenic intensity applied in combination with sound of moderate stressogenic intensity on the physiological status, non-specific resistance and adaptive capacities of the calf organism in early postnatal ontogeny.

4. To estimate the correlation between the action of low temperature of moderate stressogenic intensity and the combined action of low temperature and sound of moderate stressogenic intensity on the physiological state, non-specific resistance and adaptive capacities of the calf organism in early postnatal ontogeny.

5. To study the action of the mineral premix "PMVAS", applied separately and in combination with low temperature of moderate stressogenic intensity on the physiological stress, non-specific resistance and adaptive capacities of the organism of calves in postnatal ontogeny.

**Research hypothesis.** It consists in the fact, that the action of abiotic environmental differentiating factors of moderate stressogenic intensity and short duration acts through the hypothalamic-pituitary-adrenal axis, stimulates nonspecific reactions of the organism, modifies

the physiological state and adaptive capacities, intensifies metabolic processes and increases the productivity of animals.

**Summary of the research methodology and justification of the research methods chosen.** In accordance with the purpose and objectives of the thesis, classical physiological, anatomical, biochemical, chemical, haematological, microscopic and statistical research methods were applied, based on known conceptual principles and generally accepted methodology of conducting research: experimental methods, analysis, synthesis, comparison, generalization, conclusion, etc [13; 15; 16; 19].

**Scientific novelty and originality.** Scientifically, for the first time, the correlation of the peculiarities of the morphofunctional status of the organism of carp larvae (*Cyprinus carpio*) and calves to the action of differentiated abiotic environmental factors of moderate stressogenic intensity in early postnatal ontogeny has been studied. A directly proportional correlation was established between the response of the organism of poikilothermic (carp larvae) and homeothermic (calves) animals to the action of temperature of moderate stressogenic intensity. It has been shown that the separate action of abiotic environmental factors beneficially influences the physiological state, non-specific resistance and adaptive capacity of the organism of calves in early postnatal ontogeny, while the combined action of this factor with sound of moderate stressogenic intensity and short duration acts unfavourably, since these factors mutually amplify their stressogenic amplitudes. The influence of biologically active compounds of the mineral premix "PMVAS", administered separately and conjugated with the thermal factor of moderate stressogenic intensity on the improvement of physiological condition, increase of non-specific resistance and adaptive capacities of the organism of calves in early postnatal ontogeny and balancing of the rumen microbiota was determined.

**Scientific problem solved.** It consists in determining the favourable and unfavourable correlation of the physiological state, non-specific resistance and adaptive capacities of carp larvae (*Cyprinus carpio*), calves and rumen microbiota in the postnatal period as a function of the separate action of the thermal factor, the combined action of the thermal factor with sound and the combined action of the thermal factor with the mineral premix "PMVAS".

**Theoretical significance.** It consists in determining the variability of the physiological state and the response of the organism of poikilothermic and homeothermic animals to the action of abiotic environmental factors of moderate stressogenic intensity, determining the essential role of the cellular and humoral factor on the physiological state, non-specific resistance and adaptive capacities of the animal organism in the early postnatal period; the role of cortisol in triggering stressogenic reactions and the significance of the rumen microbiota.

**The applicative value.** It consists in the improvement of the organism welfare of carp larvae (*Cyprinus carpio*) and calves, intensification of maturation of dominant systems and organs, increase of non-specific resistance and adaptive capacities of the organism in the early postnatal period by directed and separate application of abiotic environmental factors of moderate stressogenic intensity and biologically active compounds of the mineral premix "PMVAS".

**Implementation of scientific results.** The results of the study were implemented in the experimental research activity in the Institute of Physiology and Sanocreatology (Act no.03 of 20.03.2023), in the practice of cattle breeding and maintenance in the conditions of the Scientific Institution of Training and Culturalization 'Chisinau Zoological Garden' (Act no.06 of 14.06.2023), in the process of elaboration and promotion of national normative acts on ensuring public health and environmental protection (Act no.11-07/3373 of 25.10.2023).

Based on the results of the thesis 44 scientific papers were published: 9 without co-authors, 9 articles in international journals, 5 articles in national journals, 8 articles in national and international scientific collections, 11 theses in national and international scientific collections and 2 monographs.

**Volume and thesis structure.** The thesis is set out on 134 pages and includes: introduction, chapter analysing the scientific situation in the field of the thesis, materials and methods, 4 chapters with the results obtained and their analysis, conclusions and recommendations, bibliography and appendices. The illustrative material consists of 57 tables and 13 figures. The bibliographic index contains 255 titles.

**Keywords:** carp larvae, calves, abiotic environmental factors, temperature, sound, mineral premix, stress, adaptive capacities, non-specific resistance.

## **THESIS CONTENT**

The introduction to the thesis argues the actuality, importance and necessity of the research carried out, describes the scientific novelty of the results obtained, describes the current situation in the field of research, formulates the purpose and objectives of the research, the research hypothesis, the summary of the general research methodology and the justification of the research methods.

### **1. SYNTHESIS OF INFORMATION ON THE EFFECT OF ENVIRONMENTAL FACTORS ON THE ORGANISM OF AGRICULTURAL ANIMALS IN THE EARLY POSTNATAL PERIOD**

This chapter presents and summarises relevant data from the literature, the difficulties and prospects for animal husbandry under current climatic conditions. The focus of the study was on the investigation of the action of abiotic environmental factors on the functional state, adaptive capacities and organismal resistance of carp larvae and calves in the early postnatal period. In substantiating the importance of carrying out research on animals in the first days of life, data on the periodisation of postnatal ontogeny and physiological peculiarities of the organism of the studied animals are presented. Data from the literature confirm that environmental factors are a significant problem in the process of animal husbandry. The available information points to the lack of measures to control and monitor them, which can prevent stress in animals in early postnatal ontogeny and the possibility of targeted and short-term application of environmental factors on the resistance and defence and adaptive capacities of the organism.

## **2. MATERIAL AND METHODS**

In the organization of the experiments the animals were randomly assigned to homogeneous groups according to the 'analogy' principle, with the formation of control groups. To carry out the research in the experiments, 18,000 carp larvae (*Cyprinus carpio*) and 70 calves were involved.

### ***Method of the action of the thermal factor on carp larvae in the early postnatal period.***

In these experiments the action of low temperature of moderate stressogenic intensity on carp larvae from the age of 1 (1st series), 2 (2nd series) and 3 days (3rd series) was studied with the application of temperatures of 9 °C, 12 °C, 15 °C and 20 °C.

***Method of separate action of thermal factor on calves in the early postnatal period.*** In this series of experiments the solitary action of low temperature of moderate stressogenic intensity of +5 °C on the organism of calves (20 heads) divided into two groups - the control group (CG) and the experimental group (ETG) was studied.

***Method of combined action of thermal and acoustic factors on calves in the early postnatal period.*** In this series of experiments on animals of the experimental group (ETSG) the action of low temperature of a moderate stressogenic intensity of +5 °C and sound of 70-80 db was tested. The following physiological indices in blood were studied: total protein, protein fractions (albumins,  $\alpha$ -,  $\beta$ -,  $\gamma$ -globulins) urea, glucose, alkaline reserve, macroelements - Ca, P, Na, K and their ratio, cortisol, phagocytic activity, bactericidal activity and lysozyme. As an integral index of productivity, calf body mass was monitored throughout the study period.



*The method of separate action of dietary and combined dietary and thermal factors on calves in the early postnatal period.* Calves were divided into three groups (control group - CG, experimental group, where 'PMVAS' premix was applied as feed factor - EPG and experimental group, where feed factor and heat factor were applied in combination - EPTG) of 10 heads each. The experiments were carried out on calves from 3 days old to 90 days old. The EPG and EPTG calves were given the mineral premix 'PMVAS', developed in the Institute of Physiology and Sanocreatology, in the amount of 1.5 g per 1 litre of milk consumed in the basic ration. The concentration of minerals in the premix was calculated on the basis of the physiological requirements of the organism, the content of minerals in the blood of the animals and the quantity of minerals in the feed and was as follows: cobalt carbonate 0.15 mg; copper sulphate 3.25 g; iron sulphate 20.3 g; potassium iodate 0.1 mg; manganese sulphate 15.2 g; zinc sulphate 20.5 g; sodium humate 100.0 g; calcium phosphate 100.0 g and excipient 740.5 g. At the same time, at 3, 7, 15, 20, 25, and 30 days of age the EPTG calves were subjected to the action of low temperature of moderate stressogenic intensity of +5 °C.

In this experimental series were studied: in the rumen - the amount of volatile fatty acids (VFA), the amount of aerobic, anaerobic, amylolytic bacteria and the amount of acidolactic bacilli; in the blood - the level of total protein, protein fractions, the amount of macroelements - Ca, P, Na, K, Mg, the amount of trace elements - Fe, Cu, Zn, phagocytic activity, bactericidal activity and lysozyme. As an integral index of productivity the body mass of calves was monitored.

In the process of conducting the proposed experiments, classical, modern, cross-sectional and experimental methods described in the literature were used, applied to determine the indices of protein, mineral, carbohydrate metabolism, cellular and humoral defense factor, quality and quantity of rumen microbiota and hormones responsible for triggering stress reaction in calves and their body mass weight. Depending on the intrinsic characteristics of the method, quantitative and qualitative methods and research were used to determine the size of the calf sac, length and weight of carp larvae.

### **3. INFLUENCE OF LOW TEMPERATURE OF MODERATE STRESSOGENIC INTENSITY OF DIFFERENT PARAMETERS ON THE ORGANISM OF CARP LARVAE IN EARLY POSTNATAL ONTOGENY**

Fish species used in aquaculture, as a rule, have low resistance to the action of environmental factors, which is the result of long-term selection to increase productivity and reduce the level of heterozygosity. In our opinion there are several approaches to solve the

problems that arise as a result of the negative impact of environmental factors on the growth and survival of aquatic organisms. One of these is the application of environmental factors of moderate, well-determined stressogenic intensity to organisms in the early postnatal period with the aim of increasing non-specific resistance and adaptive capacities.

Data on yolk sac sizes in carp larvae subjected to the action of different intensities of thermal factors are presented in Table 3.1.

**Table 3.1. Yolk sac dimensions in carp larvae subjected to low temperature action of moderate stressogenic intensity**

Series of experiments	Temperature applied, (°C)	Parameters studied	Yolk sac dimensions as a function of temperature application time, (mm)				
			1 day	3 days	5 days	7 days	10 days
I (1 day)	9	length	2,97±0,08	2,95±0,07	2,74±0,07	2,62±0,12	2,51±0,08*
		height	0,78±0,01	0,76±0,02	0,70±0,09	0,64±0,08	0,52±0,07*
	12	length	2,91±0,05	2,87±0,06	2,78±0,06	2,42±0,08*	1,87±0,07*
		height	0,69±0,02	0,64±0,03	0,61±0,02*	0,59±0,06	0,33±0,04*
	15	length	2,87±0,04	2,68±0,09	2,46±0,05*	1,62±0,11*	0
		height	0,62±0,02	0,52±0,04	0,46±0,03*	0,34±0,02*	0
	20	length	2,82±0,06	1,52±0,14	0,27±0,07*	0	0
		height	0,37±0,03	0,30±0,04	0,07±0,03*	0	0
II (2 days)	9	length	2,71±0,06	2,67±0,07	2,49±0,09	2,23±0,08*	1,82±0,13*
		height	0,68±0,02	0,61±0,03	0,57±0,03	0,48±0,02*	0,32±0,04*
	12	length	2,59±0,11	2,53±0,09	1,95±0,13*	1,34±0,11*	0,82±0,12*
		height	0,53±0,03	0,47±0,04	0,44±0,06	0,33±0,03*	0,14±0,02*
	15	length	2,32±0,07	2,17±0,08	0,74±0,13*	0	0
		height	0,38±0,06	0,33±0,04	0,16±0,05*	0	0
	20	length	1,97±0,08	0,89±0,12*	0	0	0
		height	0,31±0,02	0,21±0,05	0	0	0
III (3 days)	9	length	1,84±0,07	1,49±0,09*	1,17±0,05*	0,91±0,03*	0,55±0,06*
		height	0,34±0,05	0,28±0,12	0,15±0,04*	0,13±0,06*	0,09±0,01*
	12	length	1,62±0,08	1,24±0,04*	0	0	0
		height	0,21±0,01	0,16±0,02	0	0	0
	15	length	1,47±0,03	0,28±0,07*	0	0	0
		height	0,18±0,07	0,05±0,01	0	0	0
	20	length	1,38±0,04	0,18±0,03*	0	0	0
		height	0,23±0,02	0,04±0,02*	0	0	0

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

The data in Table 3.1 demonstrate that different water temperature values act differently on the rate of yolk sac absorption in carp larvae. The lower the temperature, the slower it is absorbed. A horizontal analysis of the data shows a varied decrease in yolk sac size at all thermal influences used in the experiment ( $P < 0.05$ ).

Thus, yolk sac size in 2-day-old larvae subjected to the action of the thermal factor is smaller compared to yolk sac size in 1-day-old larvae at all temperatures studied and throughout their application. It should be noted that the speed of yolk sac absorption is predetermined by the fact that the larvae of experimental series I were kept at a temperature of 20 °C (a temperature considered physiologically optimal for the incubation and development of carp larvae) for only

one day, while the larvae of experimental series II were kept at this temperature for 2 days before the start of the experiment, which allowed their bodies to develop physiologically normally for twice as long as the one-day-old larvae.

The yolk sac in carp larvae of experimental series III is maintained during all periods of application of 9 °C temperature. At temperatures of 12, 15 and 20 °C the yolk sac is recorded only up to the duration of the stressor application for 3 days. This period corresponds to the physiological age of the larvae of 6 days and is consistent with literature data on the duration of yolk sac existence [5; 12]. The yolk sac size in 3-day-old carp larvae, according to the comparative analysis of the above results, is smaller compared to the yolk sac size in 1- and 2- day-old larvae at all temperature ranges and throughout the experimental duration. In this series of experiments, the rapid yolk sac absorption in carp larvae was conditioned by the fact that they until the initiation of the experiments were maintained in optimal conditions (+20 °C) of physiological development of the organism for 3 days, which favored the intensity of energy consumption and metabolism of nutrients, causing the reduction of the yolk sac.

Another indicator studied according to the research objectives is the survival of carp larvae after the application of low temperatures (Table 3.2).

**Table 3.2. Survival of carp larvae after application of low temperatures for 10 days and at the end of the 23<sup>rd</sup> day experiment**

Ord.no.	Series of experiments	Number of surviving larvae, (heads)			
		at 9 °C	at 12 °C	at 15 °C	at 20 °C
after applying low temperatures for 10 days					
1	I	1109,7±15,23*	1127,2±14,73*	1112,4±16,77*	1048,6±17,08
2	II	1028,4±13,98	1133,9±16,11*	1115,2±16,28*	1021,4±16,49
3	III	923,6±15,43	1076,7±16,07*	954,9±14,32	918,1±17,23
at the end of the 23 <sup>rd</sup> day experiment					
4	I	1034,8±12,04*	1055,7±13,89*	1037,4±14,34*	994,3±10,07
5	II	1013,2±13,52	1073,9±10,78*	995,7±13,96	973,8±14,43
6	III	870,5±11,17	1016,3±14,06*	824,1±14,08*	864,5±13,86

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

The results (Table 3.2) show, that the highest survival of carp larvae was recorded at the temperature of 12 °C in experimental groups I, II, III and constituted after 10 days of experiments - 127.2±14.73; 1133.9±16.11, 1076.7±16.07 heads (P<0.05) and at the age of 23 days respectively - 1055.7±13.89; 1073.9±10.78 and 1016.3±14.06 heads (P<0.05) compared to the number of larvae survived in all three experimental groups in EG (+12 °C).

Thus, the most favourable temperature for survival of carp larvae at 1, 2 and 3 days of age is 12 °C applied within 10 days, at which the most efficient metabolism of nutrients in the yolk sac takes place, which contributed to the increase of nonspecific resistance and well-being of the organism.

The following investigations focused on determining larval length after application of stressogenic temperatures for 10 days (Table 3.3). Upon analysing the data (Table 3.3) on the length of carp larvae in the three experimental series at the applied temperatures of 9, 12 and 15 °C, it can be seen that the length of larvae is longer in experimental series III.

The difference of larval length in experimental series I and III constitutes at 9 °C - 1.11 mm ( $P < 0.05$ ), at 12 °C - 0.98 mm and at 15 °C - 0.94 mm.

**Table 3.3. Length of carp larvae after application of 10-day stress temperatures and at the end of the 23rd day experiment**

Ord.no.	Series of experiments	Length of carp larvae, (mm)			
		at 9 °C	at 12 °C	at 15 °C	at 20 °C
after applying low temperatures for 10 days					
1	I	8,91±0,23*	9,16±0,24*	9,68±0,27*	10,92 ±0,25
2	II	9,58±0,24*	9,75±0,27*	10,07±0,36	10,81±0,28
3	III	10,02±0,32*	10,14±0,37*	10,62±0,33	11,02±0,22
at the end of the 23rd day experiment					
4	I	15,67±0,57*	15,84±0,71*	16,02±0,64*	19,18±0,68
5	II	16,11±0,48*	17,94±0,62	17,42±0,51*	19,24±0,54
6	III	18,54±0,47*	20,72±0,57	19,88±0,45	20,07±0,48

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

Thus, it can be mentioned, that the temperature of 9 °C applied for 10 days on carp larvae exerts a more pronounced influence on the organism of larvae included in the experiment at one day of age, conditioning the stagnation of their length growth compared to the other experimental series and temperatures studied.

From the data in Table 3.3 we can see a similar trend in the parameters obtained in the experimental series at all stressogenic temperatures studied and at 23 days of age. Thus, the lowest values of larval length were recorded in experimental series I ( $P < 0.05$ ) and the highest values of body length were recorded in experimental series III ( $P < 0.05$ ).

From the data presented in the table we can report, that when applying different temperature parameters on carp larvae, whose age at the beginning of the experiments was 1, 2 and 3 days, there is a variable increase in body length and this differs from one experimental series to another and from one temperature to another, with more pronounced results in experimental series III at 12 °C temperature.

Next, according to the objectives set, the body weight of carp larvae subjected to the action of different stressogenic temperatures was studied (Table 3.4). When analysing body weights, it was found that at the start of the experiment the carp larvae in all experimental groups had practically the same weight.

In the first experimental series the difference in body weight of larvae between the groups subjected to temperature of 9 °C and 20 °C after the application of temperature for 10 days is 4.67 mg. Further this difference is more evident and at the age of 23 days, it constituted 12.58 mg, i.e. at the temperature of 20 °C it is 1.61 times higher than the weight of larvae subjected to the temperature factor of 9 °C ( $P<0.05$ ).

**Table 3.4. Body weight of carp larvae subjected to low temperature action of moderate stressogenic intensity**

Series of experiments	Age, (days)	Larval weight, (mg)			
		9 °C	12 °C	15 °C	20 °C
I (1 day)	at start of experiment (1 day)	1,91±0,13	1,87±0,16	1,88±0,14	1,90±0,17
	after temperature application for 10 days	15,45±0,31*	16,68±0,47*	17,44±0,23*	20,12±0,21
	at the end of the experiment (23 days)	20,57±0,28*	23,72±0,39*	27,16±0,45*	33,15±0,56
	diurnal increase throughout the experimental period	0,85±0,14	0,99±0,23	1,15±0,17	1,42±0,24
II (2 days)	at start of experiment (2 days)	2,12±0,24	2,18±0,18	2,14±0,31	2,17±0,36
	after temperature application for 10 days	17,84±0,52*	19,52±0,33*	18,77±0,69*	21,33±0,57
	at the end of the experiment (23 days)	23,24±0,42*	31,69±0,69	29,27±0,58*	32,92±0,49
	diurnal increase	1,01±0,23	1,41±0,29	1,29±0,22	1,46±0,26
III (3 days)	at start of experiment (3 days)	2,33±0,29	2,31±0,47	2,32±0,33	2,34±0,34
	after temperature application for 10 days	19,52±0,74	20,57±1,13	20,18±1,02	21,16±0,96
	at the end of the experiment (23 days)	27,81±0,64*	34,08±1,21	31,89±0,57	33,64±0,62
	diurnal increase	1,27±0,23	1,59±0,22	1,48±0,14	1,57±0,27

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

The highest weight gain of carp larvae throughout the experimental duration was recorded in CG and constituted  $31.25±0.37$  mg. When analysing the diurnal spore in carp larvae throughout the experimental duration, it is noted that its value becomes lower and lower as the applied temperature parameters move away from the parameters the optimum temperature of development of the organism that was applied in the CG (+20 °C).

In the second experimental series after applying the temperature for 10 days the body weight of larvae increased significantly with a maximum recording of it at the temperature of 12 °C and 20 °C, where the diurnal increase was  $1.73±0.24$  mg and  $1.92±0.31$  mg ( $P<0.05$ ). At the end of the experiment the same trend of larval weight increase is maintained with the highest recording at the temperature of 12 and 20 °C.

In the third experimental series, the body weight values of larvae from all groups oscillated insignificantly. Therefore, the value of diurnal increase in body weight of carp larvae at 12 °C temperature is close to the value of diurnal increase in larvae in CG to which 20 °C

temperature was applied. At the end of the experiments (23 days), there is a significant increase in body weight of carp larvae subjected to the action of 12 °C temperature (34.08±1.21 mg) compared to the body weight of larvae subjected to the thermal influence of 9 and 15 °C (27.81±0.64 mg (P<0.05) and 31.89±0.57 mg). The increase of larvae is explained by the fact, that the application of 12 °C temperature on them acts beneficially by stimulating the adaptive capacities and resistance of the organism, providing relatively constant growth at high level compared to the larval weight increase in the other experimental groups.

In conclusion, it can be seen that the body weight values of 1-, 2- and 3-day-old carp larvae subjected to the action of different temperatures of moderate stressogenic intensity are varied and depend on both the age of the larvae trained in the experiment and the parameters of the temperatures tested.

#### **4. DEVELOPMENTAL DYNAMICS OF CALVES IN THE EARLY POSTNATAL PERIOD AS A FUNCTION OF THE APPLICATION OF THE TEMPERATURE FACTOR OF MODERATE STRESSOGENIC INTENSITY**

##### **4.1. Increased functional status of calves subjected to low temperature of moderate stressogenic intensity in early postnatal ontogeny**

The functional status of the calves' organism to the application of stressor was assessed by the changes of blood indices of total protein and protein fractions, urea, glucose, alkaline reserve, Ca, P, Na, K and their ratio (Table 4.1, 4.2, 4.3).

**Table 4.1. Dynamics of total protein and albumin in blood serum of calves subjected to low temperature of moderate stressogenic intensity**

Ord.no.	Age of calves, (days)	Total protein, (g/l)		Albumin, (%)	
		CG	ETG	CG	ETG
1	3	78,0±2,75	78,6±2,78	31,8±2,28	38,5±2,11*
2	8	78,3±2,77	78,3±2,71	41,1±2,29	40,3±2,17
3	15	70,0±2,72	75,8±2,70	44,2±2,31	50,0±2,88
4	20	68,3±2,73	73,3±2,65	45,3±2,35	49,9±2,23
5	25	65,9±2,71	70,1±2,67	46,7±2,41	50,0±2,39
6	30	64,1±2,60	62,5±2,48*	45,0±2,38	54,1±2,94*

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

From the data presented in Table 4.1, it can be seen, that when applying low temperature of moderate stressogenic intensity on calves in early postnatal ontogeny, a tendency of increase of total protein and albumin levels in blood serum was observed. The increased albumin content, according to their specific properties, contributes to improved nutrient transport in the calf body.

Under the action of the stressor the values of protein fractions at various stages of early postnatal ontogeny change in an oscillatory manner (Table 4.2). The  $\alpha$ -globulins fraction on day 3 was 2.4-times lower in concentration than it was until the application of low temperature of

moderate stressogenic intensity ( $P<0.05$ ), and by day 15 it had decreased 1.3-times ( $P<0.05$ ). At 8, 25 and 30 days of age,  $\alpha$ -globulins content increased 1.97-times, 1.4-times and 1.17-times, corresponding to calf ages ( $P<0.05$ ).

The  $\beta$ -globulins concentration after application of the investigated stressor decreased practically throughout the experimental duration. The most pronounced changes were the decreasing  $\beta$ -globulins content at 3, 8, 25 and 30 days of age ( $P<0.05$ ) and is diametrically opposite to the dynamics of  $\alpha$ -globulins content.

**Table 4.2. Dynamics of  $\alpha$ -,  $\beta$ - and  $\gamma$ -globulins in blood serum of calves subjected to low temperature of moderate stressogenic intensity**

Ord.no.	Age of calves, (days)	$\alpha$ -globulins, (%)		$\beta$ -globulins, (%)		$\gamma$ -globulins, (%)	
		CG	ETG	CG	ETG	CG	ETG
1	3	7,6 $\pm$ 0,18	3,2 $\pm$ 0,12*	20,3 $\pm$ 0,47	18,6 $\pm$ 0,34*	40,2 $\pm$ 0,59	39,7 $\pm$ 1,37
2	8	3,8 $\pm$ 0,14	7,5 $\pm$ 0,21*	17,9 $\pm$ 0,46	13,4 $\pm$ 0,21*	37,2 $\pm$ 0,57	38,8 $\pm$ 1,36
3	15	6,8 $\pm$ 0,17	5,1 $\pm$ 0,17*	15,2 $\pm$ 0,40	19,0 $\pm$ 0,51*	33,8 $\pm$ 0,52	25,9 $\pm$ 1,23*
4	20	6,7 $\pm$ 0,16	6,9 $\pm$ 0,19	18,4 $\pm$ 0,48	17,3 $\pm$ 0,47	29,6 $\pm$ 0,43	25,7 $\pm$ 1,22*
5	25	6,6 $\pm$ 0,14	9,0 $\pm$ 0,24*	22,4 $\pm$ 0,49	15,6 $\pm$ 0,28*	24,3 $\pm$ 0,41	25,4 $\pm$ 1,20
6	30	11,5 $\pm$ 0,39	13,5 $\pm$ 0,39*	16,4 $\pm$ 0,41	11,2 $\pm$ 0,20*	26,2 $\pm$ 0,42	21,2 $\pm$ 1,18*

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

Concerning  $\gamma$ -globulins we mention, that in both batches there was a decreasing trend in their content throughout the experimental duration. The decrease in  $\gamma$ -globulins content is due to the fact that the calves' body no longer receives immunoglobulins from the mother's milk (colostrum), and the mechanisms of elaboration of their own immunoglobulins are not yet fully functional.

The application of a moderately stressful heat factor throughout the experimental duration produced pronounced changes, as determined by the determination of serum urea concentration in the animals ( $P<0.05$ ). The decrease in its concentration, possibly, is conditioned by the decrease in the intensity of protein metabolism processes. Analysis of the data obtained (Table 4.3) shows that the concentration of glucose and alkaline reserve in the blood of animals at different stages of early postnatal ontogeny vary and are mutually correlated.

**Table 4.3. Blood plasma glucose and alkaline reserve indices in calves subjected to low temperature of moderate stress intensity**

Ord.no.	Age of calves, (days)	Glucose, (mmol/l)		Alkaline reserve, (mg%)	
		CG	ETG	CG	ETG
1	3	3,33 $\pm$ 0,11	3,50 $\pm$ 0,12	340 $\pm$ 7,0	360 $\pm$ 7,2
2	8	5,56 $\pm$ 0,17	5,00 $\pm$ 0,16*	240 $\pm$ 5,8	280 $\pm$ 6,5*
3	15	5,57 $\pm$ 0,18	4,39 $\pm$ 0,14*	520 $\pm$ 9,1	320 $\pm$ 6,9*
4	20	5,31 $\pm$ 0,19	3,82 $\pm$ 0,14*	480 $\pm$ 7,9	280 $\pm$ 6,4*
5	25	5,00 $\pm$ 0,17	3,40 $\pm$ 0,13*	440 $\pm$ 8,4	240 $\pm$ 6,2*
6	30	4,75 $\pm$ 0,15	4,20 $\pm$ 0,12*	240 $\pm$ 5,9	320 $\pm$ 6,8*

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

At the same time, the decrease of glucose ( $P<0.05$ ) and alkaline reserve ( $P<0.05$ ) levels in the blood demonstrates that the mobilization of the organism's energy sources occurs in

response to the development of the stress reaction to the application of the heat factor. The level of alkaline reserve also indicates the state of acid-base balance in the body's biological fluids, which in critical periods of development deviates depending on the action of external environmental factors.

Further the main indices of salt metabolism in calves - Ca, P, Na, K, as well as the Ca:P and Na:K ratios were studied, and they show that the concentration of macroelements in the blood of calves at the action of low temperature of moderate stressogenic intensity changed oscillatingly and in different periods of early postnatal ontogeny varies differently. However, the Ca:P and Na:K ratio data show, that even if changes in the amount of macroelements occur during this period, they are within the physiological norm.

#### **4.2 Study of the resistance, adaptive capacity and growth of calves exposed to low temperature of moderate stressogenic intensity in early postnatal ontogeny**

A particular interest is the study of the organism's defence systems, the dynamics of their formation, the development of the organism's adaptive capacities to the action of low temperature of moderate stressogenic intensity. In this aspect, indices of phagocytic activity, bactericidal activity, lysosome, cortisol in blood and body weight were studied (Table 4.4, 4.5).

**Table 4.4. Phagocytic activity, bactericidal activity and lysozyme content in calves subjected to low temperature of moderate stressogenic intensity**

Ord. no.	Age of calves, (days)	Phagocytic activity, (%)		Bactericidal activity, (%)		Lysozyme, (%)	
		CG	ETG	CG	ETG	CG	ETG
1	3	40,0±0,68	42,5±0,75	28,33±0,76	35,00±0,84*	24,58±0,08	24,86±0,03
2	8	42,8±0,72	44,6±0,82	34,78±0,81	41,62±2,41*	25,95±0,24	7,13±0,21*
3	15	31,8±0,54	33,7±0,79	43,17±2,59	48,96±2,15	23,85±0,48	25,71±0,38*
4	20	32,6±0,13	34,8±0,70*	44,51±2,51	61,82±1,97*	24,55±0,22	26,18±0,31*
5	25	34,3±0,27	36,9±0,52*	45,23±2,03	69,54±2,76*	23,15±0,56	24,29±0,61
6	30	35,4±0,68	37,5±0,63*	43,94±0,90	70,93±2,80*	28,06±0,62	32,08±0,51*

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

From the data in Table 4.4 it can be seen that the cellular factor of natural (non-specific) resistance of the organism is well expressed in the first days of life in calves. Throughout the study period phagocytic activity in ETG was higher than in CG, and at 20, 25 and 30 days of age in ETG it increased to statistically significant values (P<0.05). It can be mentioned, that this increase is attributed to ecological factors, because after the 8th day after birth most of the maternal immune bodies, obtained through colostrum have been exhausted, and the own immune system is not definitely matured (immunodeficiency period).

As a result of research, it has been established that the body's protective humoral system in new-born calves is not fully developed, but is formed gradually. The obtained data show that



the application of stressogenic factor increases the bactericidal activity against CG, ( $P<0,05$ ). This significant increase is maintained throughout the research period.

Lysozyme values during the whole research period are higher in ETG compared to its values in CG. At the age of 30 days this increase is more pronounced ( $P<0,05$ ). Therefore, following the application of the stressogenic factor the defence capacities of the organism increase, as lysozyme possesses antibacterial properties, has immunomodulatory, anti-inflammatory, antitoxic effect, stimulates regeneration processes and erythropoiesis.

**Table 4.5. Cortisol levels in calves subjected to low temperature of moderate stress intensity**

Ord.no.	Age of calves, (days)	Cortisol, (mmol/l)	
		CG	ETG
1	3	92,04±2,31	97,62±2,99
2	8	98,51±2,97	105,27±3,11
3	15	112,47±3,01	109,38±3,27
4	20	112,90±3,17	117,14±2,57
5	25	113,23±2,98	127,81±3,10*
6	30	111,95±3,21	125,32±3,41*

Note: \* - differences are statistically true between the experimental and control groups ( $P<0,05$ ).

From the data in Table 4.5, it can be seen that the blood cortisol concentration evaluated according to the age of the calves and the action of the stressor and had a continuous increasing trend in both groups, except on day 15th, where there was a slight decrease in ETG compared to CG. The major increase in cortisol was recorded at 25 and 30 days of age in ETG, where it was 127.81±3.10 mmol/l and 125.32±3.41 mmol/l, compared to its value of 113.23±2.98 mmol/l and 111.95±3.21 mmol/l in CG ( $P<0,05$ ). Thus, it appears that with the maturation of the suprarenal glands and the triggering of the stress reaction the secretion of the hormone cortisol gradually intensifies and its content in the bloodstream increases, causing the organism's ability to adapt to new environmental conditions to increase.

Therefore, low temperature of moderate stressogenic intensity prolongs the adaptation period of the organism of animals in ETG compared to the organism of animals in CG. This adaptive longevity is demonstrated by the obtained indices of phagocytic activity, bactericidal activity, lysozyme and blood cortisol concentration.

When analysing the growth rate of calves in conditions of absence and application of low temperature of moderate stressogenic intensity in early postnatal ontogeny it was found, that in ETG it in all periods of development was higher compared to that of CG animals and at the age of 30 days the body weight of calves constituted 48.4±1.35 kg in ETG and was 1.14 times higher than in CG, which constituted 42.4±1.61 kg ( $P<0,05$ ).

## 5. DEVELOPMENTAL DYNAMICS OF CALVES IN THE EARLY POSTNATAL PERIOD AS A FUNCTION OF THE APPLICATION OF THE THERMAL FACTOR OF MODERATE STRESSOGENIC INTENSITY COMBINED WITH THE ACOUSTIC FACTOR OF MODERATE STRESSOGENIC INTENSITY

### 5.1. Increased functional status of calves exposed to low temperature of moderate stressor intensity combined with sound of moderate stressor intensity in early postnatal ontogeny

According to the continuity of the research, the functional state, resistance and adaptive capacities of calves in early postnatal ontogeny subjected to the combined action of the above-mentioned stressors were studied with the determination of the studied physiological parameters. The results of total protein and albumin values in blood serum are presented in Table 5.1.

**Table 5.1. Dynamics of total protein and albumin in blood serum of calves subjected to the combined action of low temperature and sound of moderate stressogenic intensity**

Ord.no.	Age of calves, (days)	Total protein, (g/l)		Albumin, (%)	
		CG	ETSG	CG	ETSG
1	3	59,2±2,49	60,1±2,63	55,3±2,64	52,1±2,41
2	8	58,3±2,50	58,3±2,51	62,2±3,08	53,5±2,47*
3	15	51,8±2,41	55,4±2,48	72,8±3,01**	65,2±2,63**
4	20	52,1±2,48	57,0±2,50	61,3±2,74	66,9±2,71**
5	25	50,5±2,51**	58,3±2,51*	50,0±2,06	69,2±2,84*,**
6	30	50,4±2,43**	54,1±2,61	65,8±2,53**	66,3±2,68**

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

\*\* - differences are statistically true compared to 3 days of age (P<0.05).

Analysis of the data in Table 5.1 shows that at ages 15, 20, 25 and 30 days the total protein values in are 6.9%, 11.5%, 15.4% and 7.3% (P<0.05) higher than in CG. Note that both in CG and ETSG total protein has a decreasing trend throughout the experiment. Total protein in CG decreases sharply from day 8 to day 30 (P<0.05). In ETSG the protein value has an oscillatory character, with a statistically true decrease at 25th day (P<0.05).

Following analysis the albumin content in CG varies in an oscillatory manner from 55.3±2.64% (3 days) to 72.8±3.01% (15 days) (P<0.05), then decreases to 50.0±2.06% (25 days) and then increases to 65.8±2.53% (30 days) (P<0.05). The amount of albumin in the blood of ETSG calves increases throughout the experiment, reaching a maximum value at 25th day of age (69.2±2.84%) (P<0.05), after which there is a slight decrease to 66.3±2.68% (P<0.05).

It is known that globulins are proteins responsible for the immunological status of the animal organism, the results of their research are presented (Table 5.2).

The  $\alpha$ -globulins values in calves subjected to the combined action of low temperature and

sound of moderate stressogenic intensity (Table 5.2) at 3rd and 8th day had a lower concentration (2.8 times and 2.9 times respectively) than in CG calves ( $P<0.05$ ) and at 15th day was practically equal to its values in CG.

**Table 5.2. Dynamics of  $\alpha$ -,  $\beta$ - and  $\gamma$ -globulins in calves subjected to the combined action of low temperature and sound of moderate stressogenic intensity**

Ord.no.	Age of calves, (days)	$\alpha$ -globulins, (%)		$\beta$ -globulins, (%)		$\gamma$ -globulins, (%)	
		CG	ETSG	CG	ETSG	CG	ETSG
1	3	10,5 $\pm$ 0,31	3,7 $\pm$ 0,12*	14,5 $\pm$ 0,39	25,2 $\pm$ 0,41*	19,7 $\pm$ 0,56	19,0 $\pm$ 0,29
2	8	7,2 $\pm$ 0,30	2,5 $\pm$ 0,11*	14,3 $\pm$ 0,42	25,4 $\pm$ 0,44*	16,3 $\pm$ 0,47	18,6 $\pm$ 0,29*
3	15	6,3 $\pm$ 0,29	6,5 $\pm$ 0,18	11,5 $\pm$ 0,38	20,7 $\pm$ 0,42*	9,4 $\pm$ 0,26	7,6 $\pm$ 0,28*
4	20	15,8 $\pm$ 0,43	8,7 $\pm$ 0,21*	14,9 $\pm$ 0,43	18,1 $\pm$ 0,38*	8,0 $\pm$ 0,21	6,3 $\pm$ 0,21*
5	25	26,7 $\pm$ 0,97	11,5 $\pm$ 0,25*	18,3 $\pm$ 0,45	13,6 $\pm$ 0,36*	5,0 $\pm$ 0,19	5,7 $\pm$ 0,19*
6	30	15,9 $\pm$ 0,54	13,0 $\pm$ 0,39*	9,1 $\pm$ 0,27	11,9 $\pm$ 0,32*,**	9,2 $\pm$ 0,24	8,8 $\pm$ 0,24

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

\*\* - differences are statistically true compared to 3 days of age ( $P<0.05$ ).

Then, at 20th and 25th days of age, a similar decrease as at 3rd and 8th days of age of  $\alpha$ -globulins value in ETSG of 1.8 times and 2.3 times respectively ( $P<0.05$ ) was observed. Note that throughout the experimental duration the  $\alpha$ -globulins value is lower in ETSG ( $P<0.05$ ).

The  $\beta$ -globulins values in ETSG calves increase essentially throughout the duration of the research compared to CG (exception is 25th day) ( $P<0.05$ ). At the same time, we note that the amount of  $\beta$ -globulins in the blood of ETSG calves throughout the research period decreases uniformly ( $P<0.05$ ).

When analysing the  $\gamma$ -globulins data (Table 5.2), a decrease in the amount of  $\gamma$ -globulins in ETSG compared to the amount of  $\gamma$ -globulins in CG is observed ( $P<0.05$ ).

Thus, in early postnatal ontogeny the dynamics of protein fraction values is characterized by decreasing  $\alpha$ -globulins concentration in the early period. Subsequently, after the 15th day their increase occurs. In the case of  $\beta$ - and  $\gamma$ -globulins an increase in their concentration was established at 8th day, more expressed of  $\beta$ -globulins (1.8 times,  $P<0.05$ ) and less evident of  $\gamma$ -globulins (1.2 times,  $P<0.05$ ).

From the above we can see that the combined action of low temperature and moderate stressful sound intensity on the calves' organism causes oscillatory changes in the protein metabolism indices. The increase in the level of protein fractions, to a large extent, correlates with the decrease in the level of total protein and therefore increases the immunological status and non-specific resistance of the animal organism.

Other indices that characterise the functional status of the organism and the character of the development of the stress response are the level of glucose and alkaline reserve Table 5.3.

The data in Table 5.3 show that the combined action of the studied factors increased the glucose level throughout ontogenesis in ETSG, where at the 15th day it increased by 1.86 times

( $P < 0.05$ ), except at the 25th day after birth, where it decreased by 1.66 times ( $P < 0.05$ ).

**Table 5.3. Glucose content and alkaline reserve in calves subjected to the combined action of low temperature and sound of moderate stressogenic intensity**

Ord.no.	Age of calves, (days)	Glucose, (mmol/l)		Alkaline reserve, (mg%)	
		CG	ETSG	CG	ETSG
1	3	3,11±0,10	4,20±0,13*	320±6,8	340±7,0
2	8	6,66±0,24	7,77±0,21*	440±8,3**	480±8,5*,**
3	15	3,88±0,14	7,21±0,26*	360±6,9	280±6,5*
4	20	3,42±0,13	5,21±0,17*	300±6,4	240±5,9*
5	25	5,55±0,18	3,35±0,12*	240±6,2**	200±5,4*,**
6	30	4,40±0,14	4,23±0,12	400±8,1**	440±8,5*,**

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

\*\* - differences are statistically true compared to 3 days of age ( $P < 0.05$ ).

Changes in the dynamics of alkaline reserve (Table 5.3), like changes in glucose, were variable in character with an increase in its level in both groups up to day 8 ( $P < 0.05$ ), followed by a phase of decrease in its concentration up to the 25th day ( $P < 0.05$ ), followed by a phase of increase at the 30th day ( $P < 0.05$ ). Here we observe a reciprocal correlation of alkaline reserve level with blood glucose level.

Thus, the decrease in glucose and alkaline reserve levels in response to the combined action of the complex of stressors demonstrates that the mobilization of energy resources in the body occurs in response to the development of the stress reaction.

Another physiological index that characterises the functional state of the organism to the action of environmental factors is the level of salt metabolism, which is relatively stable throughout the experiments.

## **5.2 Study of resistance, adaptive capacity and growth of calves exposed to low temperature of moderate stressogenic intensity combined with sound of moderate stressogenic intensity in early postnatal ontogeny**

The indices of phagocytic activity, bactericidal activity and lysozyme quantity obtained are presented in Table 5.4. From the data in Table 5.4 it can be seen, that phagocytic activity at the 8th day reached the highest value of  $45.3 \pm 0.84\%$  in ETSG and  $42.5 \pm 0.77\%$  in CG ( $P < 0.05$ ). Subsequently, there was an essential decrease in phagocytic activity in both groups. In this case, it can be mentioned that the changes in phagocytic activity are conditioned by the mode and intensity of application of the ecological factors studied.

The bacteriostatic properties of blood serum, are an integrated expression of antimicrobial properties, which are part of the humoral factors of the non-specific defence of calves from the first days of life. The data of Table 5.4 show, that the bactericidal properties of blood are gradually formed, which is in accordance with the data of scientific literature [11; 20].

**Table 5.4. Phagocytic activity, bactericidal activity and lysozyme content in calves subjected to the combined action of low temperature and sound of moderate stressogenic intensity**

Ord. no.	Age of calves, (days)	Phagocytic activity, (%)		Bactericidal activity, (%)		Lysozyme, (%)	
		CG	ETSG	CG	ETSG	CG	ETSG
1	3	40,8±0,69	41,5+0,78	31,0±1,43	37,0±1,11*	24,21+0,07	24,42+0,03
2	8	42,5±0,77	45,3+0,84*	38,0±0,84	47,0±2,01*	26,52+0,19	27,35+0,19*
3	15	31,4±0,56*	34,9±0,79*	42,0±1,25	50,0±1,76*	25,34+0,32	26,76+0,35*
4	20	32,8±0,64	33,7±0,82	44,0±2,51	58,0±1,54*	24,16+0,32	25,76+0,33*
5	25	34,0±0,84	37,7±0,66*	49,0±2,14	67,0±2,13*	24,53+0,71	27,90+0,78*
6	30	35,8±0,80	35,1±0,52	55,0±2,03	62,0±1,87*	25,89+0,69	29,34+0,76*

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

Thus, upon combined application of stressors the value of bactericidal activity increases compared to CG, which is maintained throughout the research period (P<0.05).

As can be seen from the data in Table 5.4 the lysozyme values in both batches oscillate variably with a significant increase at the 8th and 30th day compared to its values in the same batches (P<0.05). At the same time, the lysozyme values throughout the research period are higher in ETSG compared to its values in CG (P<0.05). The increase in the amount of lysozyme demonstrates, that following the application of the stressor, the defence capacities of the organism increase, because lysozyme is one of the components of the humoral factor of the organism's resistance.

Cortisol was also studied as an index of the development of the body's adaptive capacities to the action of the stressors investigated (Table 5.5). Thus, it was found (Table 5.5.), that the cortisol concentration in the blood of calves subjected to the action of the factors analysed evaluated uniformly in an increasing manner according to the age of the calves, except for the 15th day, when a slight decrease was recorded in ETSG (106.0±3.04 mmol/l).

**Table 5.5. Cortisol levels in calves subjected to the combined action of low Temperature and moderately stressful sound intensity**

Ord.no.	Age of calves, (days)	Cortizol, (mmol/l)	
		CG	ETSG
1	3	88,2±2,71	92,7±2,84
2	8	109,1±3,11	112,4±3,15
3	15	114,7±3,01	106,0±3,04
4	20	118,1±2,93	121,3±3,02
5	25	127,2±3,14	132,6±3,43
6	30	125,1±3,39	138,3±3,47*

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

In the elucidated context it is worth mentioning, that the high amount of cortisol causes a higher stressogenic reaction of the organism to the combined action of stressors, compared to their solitary action.

Analysing the growth time of calves subjected to the combined action of stressors in comparison with the growth rate of calves in CG, it was found that the body weight of calves was lower in ETSG ( $41.9 \pm 1.37$  kg) than in CG ( $42.7 \pm 1.59$  kg), and the body weight after separate application of stressors (ETG) was 6.5 kg higher than in ETSG ( $P < 0.05$ ).

In connection with this it can be noted, that the combined action of low temperature and sound of moderate stressogenic intensity negatively influences the development of the integral index of the functional state of the organism, which is represented in our study by the increase in body weight of calves.

## **6. DEVELOPMENTAL DYNAMICS OF CALVES AS A FUNCTION OF THE INFLUENCE OF NUTRITIONAL AND THERMAL FACTORS IN THE POSTNATAL PERIOD**

### **6.1. Study of the functional state of calves subjected to the action of the mineral premix "PMVAS" and low temperature of moderate stressogenic intensity in the postnatal period**

Research carried out on animals in the first months of life has shown that the basic ration of calves does not ensure normal homeostasis and can be classified as a moderate stress factor. In this context, it was necessary to study the separate and combined action of the dietary factor (mineral premix 'PMVAS') and the thermal factor ( $+5$  °C) on the organism of calves in the postnatal period. The dynamics of the fermentation processes at different ages of calves are shown in Table 6.1. The data in Table 6.1 show that at the 30th days of age of calves there is no obvious trend of increased fermentation processes in the experimental groups. This state of affairs changes concomitantly with calf growth and is confirmed by the indices studied at the 60th and 90th day of age ( $P < 0.05$ ).

**Table 6.1. Evolution of the amount of VFA in the ruminal content of calves subjected to the separate and combined action of feed and thermal factors**

Ord.no.	Batch of animals	Content of volatile fatty acids, (ml/l)		
		30 days	60 days	90 days
1	CG	$7,07 \pm 0,47$	$7,07 \pm 0,41$	$10,40 \pm 1,25^{**}$
2	EPG	$7,50 \pm 0,60$	$10,27 \pm 0,57^{*,**}$	$11,53 \pm 0,15^{**}$
3	EPTG	$7,07 \pm 0,17$	$9,33 \pm 0,40^{*,**}$	$11,87 \pm 0,66^{**}$

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

\*\* - differences are statistically true between age groups in the same batch of the experiment ( $P < 0.05$ ).

Experimentally, it was found that this relative equalisation of the concentration of volatile fatty acids (VFA) in the rumen of calves from all experimental groups at the 90th day of age is

conditioned by the fact that towards the end of this period the calves no longer receive milk or mineral premix.

The character of fermentation processes in the rumen cavity is largely determined by the vital activity and the variety of rumen biocenosis composition (Table 6.2). The amount of aerobic bacteria in the rumen of calves from all lots at the age of 30 days is relatively high, then its dynamics has an oscillatory character with a tendency to decrease towards the age of 90 days.

**Table 6.2. Amount of microorganisms in 1 ml of ruminal content in calves subjected to separate and combined action of feed and heat factors, (lg(x))**

Age of calves, (days)	Batch of animals	Direct accounting, (c/ml)	Peptonized jealousy		Acidolactic bacilli	Amylolytic bacteria
			Aerobic bacteria	Anaerobic bacteria		
30	CG	2,25±0,30	1,90±0,10	1,81±0,05	1,93±0,11	1,83±0,06
	EPG	2,33±0,35	1,96±0,13	1,77±0,02	1,87±0,08	1,91±0,10
	EPTG	2,35±1,36	1,90±1,10	1,75±1,01	1,86±1,08	1,90±1,10
60	CG	2,31±0,34	1,81±0,05	1,86±0,08	1,60±0,03	1,83±0,06
	EPG	2,34±0,35	1,88±0,09	1,73±0,02	1,96±0,11*	1,82±0,05
	EPTG	2,41±1,39	1,94±1,12	1,92±1,11	1,95±1,12	1,88±1,08
90	CG	2,21±0,28	1,84±0,06	1,81±0,04	1,62±0,04	1,80±0,04
	EPG	2,29±0,32	1,87±0,08	1,98±0,14	1,88±0,07*	1,64±0,05*
	EPTG	2,38±1,37	1,83±1,06	1,89±1,09	1,86±1,07	1,80±1,04

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

At the same time, at the age of 90 days there is an increasing trend in the amount of anaerobic bacteria in EPG and EPTG compared to its value at the age of 30 days.

Thus, this composition of the ruminal biocenosis is predetermined by the more frequent consumption of feed by calves at this age, which also conditioned the increase of anaerobic bacteria and the reduction of aerobic bacteria.

With reference to acidolactic bacilli, a preponderance was observed at the 60th and 90th day of age in EPG (P<0.05) and EPTG.

The amount of amylolytic bacteria tended to decrease in EPG (60 days) and varied significantly at the age of 90 days (P<0.05). The dynamics of the amount of amylolytic bacteria in EPTG was also decreasing showing a uniform decreasing character throughout the experiment.

Therefore, the mineral premix 'PMVAS', applied separately or in combination with the thermal factor on calves, had a stimulating influence on the functional formation of the rumen, which was manifested by a true increase of fermentation processes in the rumen of animals from both experimental groups at different age periods.

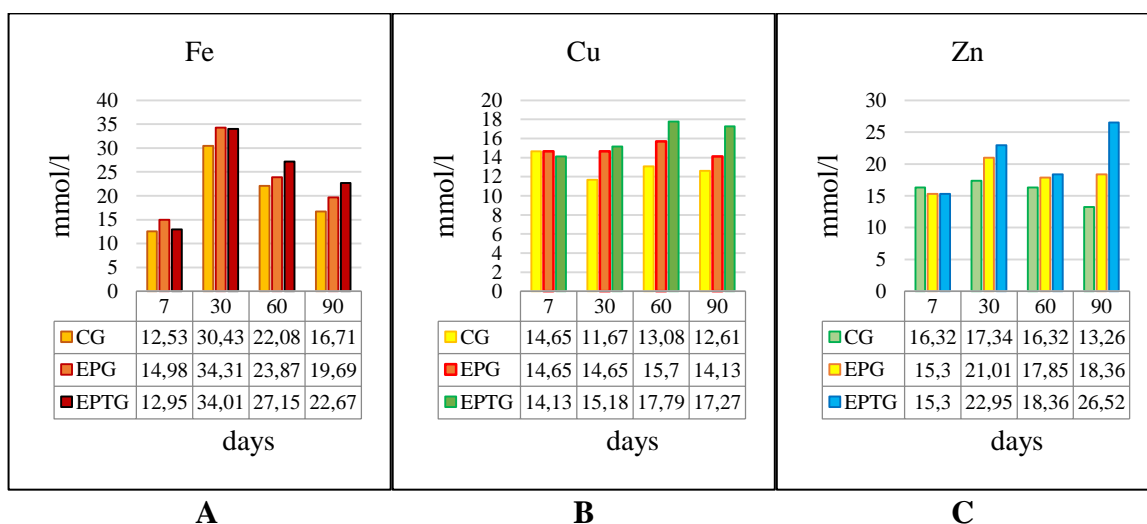
The separate action of the mineral premix 'PMVAS' and its combined action with the thermal factor on homeostasis of the organism was studied according to the indices of

macroelements - calcium, phosphorus, potassium, sodium, magnesium and according to the indices of microelements - iron, copper and zinc.

The results obtained from the study of macroelements indicate a physiological functioning of the organism and, consequently, an increase in the adaptive capacities of calves and optimal maintenance of the osmotic balance of the cytosol and extracellular fluid. Also, based on the direct correlation properties of Mg with Ca and P, it is involved in fat, carbohydrate-protein metabolism, protein biosynthesis and enzyme activation.

The evolution of Fe, Cu and Zn concentration in the body is shown in Figure 6.1.

The Fe content in the experimental animals shows a significant increase in blood plasma at the age of 30 days ( $P < 0.05$ ). In the later periods of the experiment (60 and 90 days), the amount of Fe in all three groups decreases, with higher values in the experimental groups.



**Fig. 6.1. Iron, copper and zinc indices in blood of calves subjected to separate and combined action of dietary and thermal factors**

The higher amount of Fe, recorded in the experimental batches, according to the properties, exerts a major importance in respiration and tissue nutrition, contributing to anaemia prophylaxis and enhancing immunological reactivity of the animals.

The amount of Cu and Zn in blood serum (Figure 6.1.B, 6.1.C) in experimental batches is higher compared to CG. Thus, the high level of Cu in all experimental groups conditions the increase of haemopoiesis, rumen microbiota activity, functional status of endocrine and nervous system, skeletal development and increased animal productivity. The experimentally obtained high amount of Zn, according to its properties, influences the activity of the prestomata microbiota, regulates the reproductive function and participates in osteogenesis.

Next, indices of protein metabolism were studied (Table 6.3).



**Table 6.3. Total protein and albumin content in blood of calves subjected to separate and combined action of dietary and thermal factors**

Ord.no.	Age of calves, (days)	Total protein, (g/%)			Albumin, (%)		
		CG	EPG	EPTG	CG	EPG	EPTG
1	7	6,97±0,57	6,16±0,59	6,01±0,22	53,22±5,21	65,94±7,03	56,81±4,98
2	30	6,49±0,08	5,70±0,09*	5,53±0,17*	50,66±0,72	57,69±1,93*	55,87±1,23*
3	60	6,37±0,05	5,88±0,27	6,11±0,29	41,92±3,09	43,06±4,85**	38,80±6,13
4	90	7,34±0,38	7,25±0,17	7,19±0,34**	35,53±6,83	34,58±4,57**	35,76±5,04**

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

\*\* - differences are statistically true between age groups in the same batch of the experiment (P<0.05).

From the data in Table 6.3 it can be seen that the amount of total protein in both experimental groups is lower than in CG throughout the study period. When analysing the data on the albumin content in the calves' blood, it was noted that the amount of albumin in the blood of calves decreases in age dynamics throughout the experiment in all three groups. When comparing the albumin data of the experimental groups with those of the CG at the age of 7 and 30 days the albumin value is higher in the experimental groups (P<0.05). This high amount of albumin, according to the properties, contributes to the maintenance of oncotic pressure and has the role of transport of various compounds, such as free fatty acids, bilirubin, hormones, metal ions.

The amount of globulins in the blood of calves was then analysed (Table 6.4).

**Table 6.4. Content of  $\alpha$ -,  $\beta$ -,  $\gamma$ -globulins in blood of calves subjected to separate and combined action of dietary and thermal factors**

Ord.no.	Age of calves, (days)	Globulins, (%)	Batch of animals, (%)		
			CG	EPG	EPTG
1	7	$\alpha$ -globuline,	6,75±1,62	5,79±1,19	10,97±1,66
2	30		7,30±1,02	6,72±1,04	7,89±1,95
3	60		7,16±2,58	6,36±1,38	6,98±1,70
4	90		5,81±0,85	6,22±0,80	4,78±1,56**
5	7	$\beta$ -globuline,	11,22±0,61	7,91±0,85*	9,06±1,76
6	30		9,21±0,71	9,76±0,84	10,77±1,77
7	60		23,28±1,12**	21,62±2,45**	21,47±2,29**
8	90		24,32±3,01**	23,44±2,27**	21,78±1,98**
9	7	$\gamma$ -globuline,	22,40±2,41	14,57±2,12*	12,20±1,96*
10	30		25,54±1,74	19,12±2,55	17,61±2,00*
11	60		20,73±1,96	22,60±3,71	25,77±5,88
12	90		28,54±4,23	29,56±3,82**	32,92±4,74**

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

\*\* - differences are statistically true between age groups in the same batch of the experiment (P<0.05).

In EPTG, the amount of  $\alpha$ -globulins was initially higher, after which it decreased significantly towards the 90th day, obtaining the lowest value during the whole experimental period in all groups ( $P<0.05$ ).

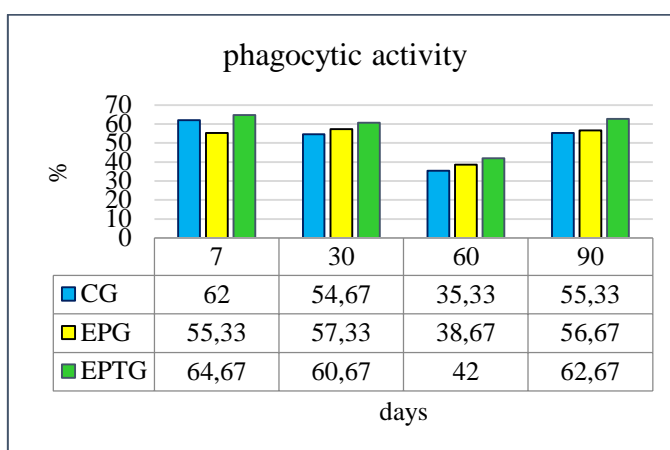
$\beta$ -globulins increase throughout the experiment in all three batches except day 30 in CG ( $P<0.05$ ). Concerning  $\gamma$ -globulins it can be mentioned, that the mineral premix 'PMVAS' had a positive effect in EPG and EPTG on the percentage content of  $\gamma$ -globulins at the age of 2 and 3 months after birth, globulins that characterize the immunological status of the organism of the animals.

In accordance with the above, it is possible to mention, that the separate and combined action of the dietary factor with the thermal one had an uneven influence on the protein metabolism indices, analysed in dynamics, according to the tested ages of the calves.

### 6.2 Study of the resistance, adaptive capacities and growth of calves subjected to the action of the mineral premix "PMVAS" and low temperature of moderate stressogenic intensity in the postnatal period

The separate and combined action of dietary and thermal factors on phagocytic activity in the blood of calves in postnatal ontogeny was further investigated (Figure 6.2).

Phagocytic activity in calves of the experimental groups at the age of 30, 60 and 90 days was higher than in CG. The introduction of the mineral premix 'PMVAS' in the calves' ration increased the biological value of the feed ration, which has a beneficial effect on phagocytic activity. At the same time, the combined application of the thermal factor of moderate stressogenic intensity with the dietary factor exerted a more pronounced effect on the increase of phagocytic activity and thus a synergistic effect of these factors was observed.



**Fig. 6.2. Phagocytic activity in the blood of calves subjected to the separate and combined action of heat and food factors**

Another factor studied that represents the resistance and adaptive capacities of the calf organism is the bactericidal activity (Table 6.5).

**Table 6.5. Bactericidal activity in the blood of calves subjected to the separate and combined action of dietary and thermal factors**

Ord.no.	Age of calves, (days)	Batch of animals	Bactericidal activity (%)		
			1 hour	3 hours	6 hours
1	7	CG	80,00±3,00	79,33±4,06	81,33±1,34
2		EPG	71,67±3,76	75,33±6,65	84,67±4,38
3		EPTG	64,33±2,61*	82,33±3,53	90,33±6,70
4	30	CG	83,00±1,00	88,00±2,65	92,00±2,74
5		EPG	89,00±1,53*	89,67±1,45	94,33±0,88
6		EPTG	88,67±2,97	90,33±1,20	94,00±1,16
7	60	CG	89,33±4,67	87,67±1,45	89,33±4,67
8		EPG	90,33±0,33	90,33±0,33	90,33±0,33
9		EPTG	91,00±1,16	88,33±3,93	91,00±1,16
10	90	CG	66,00±3,22	76,67±1,34	80,33±2,61
11		EPG	68,67±0,67	71,00±0,58*	73,33±0,88*
12		EPTG	71,33±3,34	82,33±3,39	88,33±2,19

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

At the 1-hour exposure bactericidal activity in EPG and EPTG was higher throughout the study period compared to CG, showing veridical values in EPTG at the age of 7 days and EPG at the age of 30 days (P<0.05). At the 3 and 6 hour exposure there was an increase in bactericidal activity in the experimental groups throughout the study period, except on the 90th day when there was a decrease in EPG compared to CG (P<0.05). At the 6 hour exposure bactericidal activity in ETPG was higher compared to that in CG and EPG throughout the study period. This allows to mention, that the combined action of the studied factors acts beneficially on the value of bactericidal activity and prolongs its action in time. The experimental data obtained show that increasing the biological value of the ration, by including the mineral premix, acted positively on the cellular and humoral link of the natural resistance of the animals in postnatal ontogeny.

The productivity dynamics of the experimental animals are shown in Table 6.6.

**Table 6.6. Body weight dynamics of calves subjected to separate and combined action of feed and heat factors**

Ord.no.	Batch of animals	Weight, (kg)			
1	CG	32,77±0,86	47,38±1,37	67,82±1,99	90,90±1,11
2	EPG	32,23±0,70	47,32±1,63	73,20±1,42*	96,20±1,35*
3	EPTG	32,55±1,08	47,34±2,09	69,50±1,88	95,80±3,21

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

From the data in Table 6.6 it can be seen that at the start of the experiments the average weight of the calves was practically equal. At the age of 30 days no difference in body weight of

calves is observed between CG and experimental calves. At the age of 30 days the mineral premix 'PMVAS' had a positive influence on the biochemical indices investigated and described above, but on productivity it did not show particular changes. This shows that the positive deviations of biochemical indices of experimental animals were sufficient only for the increase of adaptive capacities and functional stabilization of the organism, but not for the increase of body mass. At the age of 60 days the mineral premix 'PMVAS' acted positively on the productivity of the animals. This increase was maintained at the age of 90 days. Body weight of calves at this period was  $90.9 \pm 1.11$  kg in CG,  $96.2 \pm 1.35$  kg ( $P < 0.05$ ) in EPG and  $95.80 \pm 3.21$  kg ( $P < 0.05$ ) in EPTG. During the whole research period (from 7 to 90 days) the daily body weight gain in EPG was 770 g, in EPTG 762 g and was higher than in CG, which was 700 g.

### GENERAL CONCLUSIONS

1. Growth, development, functional status, resilience and adaptive capacities of agricultural animals, of different species, in the early postnatal period occurs as a function of the duration of application and the moderate stress intensity of environmental factors.

2. Rearing 1- and 2-day-old carp larvae (*Cyprinus carpio*) at water temperatures of 9 °C and 12 °C for 10 days results in the retention of their development with retention of the yolk sac for up to 10-12 days after hatching; rearing 1-, 2- and 3-day-old larvae at water temperatures of 12 °C for 10 days produces the highest survival; rearing 3-day-old larvae at water temperatures of 12 °C causes the highest weight gain and the greatest length.

3. Directed action of low temperature of moderate stressogenic intensity in early postnatal ontogeny on carp larvae conditions the rate of yolk sac uptake and therefore creates opportunities for directed influence on larval development duration and speed, which reflects on survival, body mass and quality of carp juveniles.

4. Application of low temperature of moderate stressogenic intensity in early postnatal ontogeny to calves produced a quantitative decrease in total blood protein, a redistribution of protein fraction content (increased amounts of albumin and  $\alpha$ -globulin and decreased  $\beta$ - and  $\gamma$ -globulin) and an obvious variability of protein metabolism by-products, indicating about intensification of nutrient transport processes, including protein metabolism.

5. Changes in glucose concentration and alkaline reserve in calf blood under the action of low temperature of moderate stressogenic intensity during early postnatal ontogeny are in mutually decreasing correlation and produce mobilization of the organism's energy resources in response to the development of the stress response to the application of the thermal factor.

6. Phagocytic activity, bactericidal activity, lysozyme and cortisol content in calves increase under the action of low temperature of moderate stressogenic intensity and demonstrate the fact, that the cellular defence factor is more expressed in the first days of life, while the humoral one evolves gradually and is more expressed after the 30th day after birth, as well as about the intensification of adaptation processes of the organism of calves.

7. Combined application of low temperature and sound of moderate stressogenic intensity in early postnatal ontogeny in calves produced contradictory changes in the physiological parameters studied with beneficial effects on some indices of natural resistance, such as phagocytic activity, bactericidal activity and lysozyme content, but on body mass growth as a quantitative index of productivity acting unfavourably.

8. Mineral premix 'PMVAS' applied separately or in combination with low temperature of a moderate stressogenic intensity had a stimulating influence on the functional formation of rumen, which was manifested by the veridical increase of fermentation processes in the rumen of animals, determined by the vital activity and variety of rumen biocenosis composition.

9. Application of mineral premix 'PMVAS' and thermal factor increases the content of calcium, phosphorus, potassium, sodium, magnesium, iron, copper and zinc in the blood serum of calves, which causes a moderate intensification of macroelement metabolism in age dynamics, optimizes the functional state of the gastrointestinal tract, increases the natural resistance and adaptive capacities of the organism, maintains the osmotic balance of the cytosol and extracellular fluid and manifests positive effects on the diurnal weight gain of calves.

10. Study of the action of climatic factors on poikilothermic (carp larvae) and homeothermic (calves) animals has produced similar results, demonstrating the possibility of substituting homeothermic animals for experiments with poikilothermic animals, particularly when it is necessary to train a large number of homogeneous experimental material in experiments, since up to 1000000 eggs can be obtained from an adult female carp.

11. Solitary or combined application of ecological factors (temperature and sound) of moderate stressogenic intensity to calves in the early postnatal period has established a reciprocal correlation between bactericidal activity (BA) and cortisol (CR) values, and their ratio (BA:CR) can be used in physiology as a parameter for estimating the organism's adaptive capacities and resistance to stressors.

12. The experimental study demonstrates the need to revise the technology of industrial breeding and maintenance of agricultural animals, of different species, according to the beneficial action of environmental factors of a stressful intensity matured in the early postnatal period.

## PRACTICAL RECOMMENDATIONS

1. It is recommended in breeding units during the first days of life of carp larvae, to apply low temperatures of moderate stressogenic intensity, to select individuals showing major individual characteristics of adaptation to low temperatures, to train these larvae and their offspring in commercial production and in the following spawning cycles, in order to strengthen conditioned adaptive characteristics and phenotype in general.

2. Periodic low temperature stressing of calves of moderate stressogenic intensity up to 30 days of age is recommended in order to raise the organism's resistance and adaptive capacities during this period, which can be maintained throughout life, since physiological maturation of the various systems of the organism occurs in the early postnatal ontogeny period and this process can be directed.

3. It is recommended to include the mineral premix 'PMVAS' in the calves' feed ration, which acts positively on the cellular and humoral link of the animals' natural resistance in postnatal ontogeny, manifested by increasing adaptive capacities, reducing the consequences of stress caused by environmental factors and stimulating early maturation of the rumen microbiome.

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1.2. cărți de specialitate colective (cu specificarea contribuției personale)

1. **BALACCI, S., BALAN, I.** *Factorii de mediu și incidența rabiei în biodiversitatea animală a Republicii Moldova*. Chișinău: Tipografia PRINT-CARO SRL, 2022. 255 p. ISBN 978-9975-164-99-3.
2. **BALACCI, S., BALAN, I., CREȚU, R.** *Alimentația echilibrată – factor vital al biodiversității Grădinii Zoologice*. Chișinău: Tipografia PRINT-CARO SRL, 2024. 335 p. ISBN 978-9975-180-16-0.

### 2. Articole în reviste științifice

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3. **BALACCI, S.** The influence of the mineral pemix “pmvs” on the functional state and adaptive capacities of calves in the postnatal period. In: *Oltenia. Studii și comunicări. Științele Naturii*. 2021, Tom. 37, Nr. 2, pp.148-156. ISSN 1454-6914.

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12. **BALACCI, S.** Influența temperaturii scăzute de o intensitate stresorică moderată asupra unor indici ai rezistenței vițelilor în ontogeneza postnatală timpurie. În: *Studia Universitatis Moldaviae. Științe reale și ale naturii*. 2021, Nr. 6(146). p.54-59. ISSN 1814-3237; ISSN 1857-498X. (Cat. B).
  13. **BALACCI, S.** Rolul medicamentelor de uz veterinar și al premixurilor minerale în asigurarea bunăstării și sănătății animalelor agricole. *Studia Universitatis Moldaviae. Științe reale și ale naturii*. 2021, nr.1 (141), p.127-132. ISSN 1814-3237 ISSN online 1857-498X. (Cat. B).
  14. **BALACCI, S.** Influența temperaturii scăzute de o intensitate stresorică moderată asupra unor indici ai metabolismului proteic la vițelii în ontogeneza postnatală. *Buletinul Academiei de Științe a Moldovei. Științele vieții*. 2021, nr. 1 (343), p.24-31. doi: 10.52388/1857-064X.2021.1.03. ISSN 1857-064X. (Cat. B).



## ANNOTATION

**Of the thesis entitled "The particularities of adaptive capacities and the resistance of carp larvae and calves depending on the influence of environmental factors", Presented by the candidate Balacci Serghei for obtaining the degree of Doctor in Biological Sciences with specialty 165.01. Human and animal physiology, Chisinau, 2024.**

**Dissertation structure.** The dissertation consists of an introduction, 6 chapters, conclusions and recommendations, bibliography of 255 titles, 134 pages of basic text, 13 figures, 57 tables. The obtained results are published in 44 scientific works with a volume of over 42 sheets of author.

**Keywords:** carp larvae, calves, abiotic environmental factors, temperature, sound, mineral premix, adaptation, resistance, stress.

**Research purpose.** Evaluation of the separate and conjugate action of abiotic environmental factors of a moderate stressogenic intensity on the vitality and morphofunctional status of the body of carp larvae (*Cyprinus carpio*) and calves in early postnatal ontogenesis.

**Research objectives.** Research of the action of different low temperature regimes of a moderate stressogenic intensity on carp larvae; evaluation of the functional state, resistance and adaptive capacities of the calf body in the early postnatal ontogenesis according to: - the action of the low temperature of a moderate stressogenic intensity, applied separately and in conjunction with the sound of a moderate stressogenic intensity, - the study of the action of the mineral premix "PMVAS", applied separately and in conjunction with the low temperature of a moderate stressogenic intensity.

**Scientific novelty and originality.** The correlation of the particularities of the morphofunctional status of the body of carp larvae and calves to the action of different abiotic environmental factors of a moderate stressogenic intensity in the early postnatal ontogenesis was studied for the first time. A directly proportional correlation of the body response of poikilothermic and homeothermic animals to the action of temperature of a moderate stressogenic intensity was established. It has been demonstrated that the separate action of abiotic environmental factors favorably influences the physiological state, non-specific resistance and adaptive capacity of the calf body in the early postnatal ontogenesis, and the conjugate action of this factor with the sound of a moderate and short-term stressogenic intensity, acts unfavorably, because these factors mutually amplify their stress amplitudes. The influence of the biologically active compounds of the mineral premix "PMVAS", administered separately and in conjunction with the thermal factor of a moderate stressogenic intensity, on the improvement of the physiological state, the increase of the non-specific resistance, as well as the adaptive capacities of the calf body in the early postnatal ontogenesis and the balance of the rumen microbiota was determined.

**The result obtained.** Scientific problem solved consists in determining the favorable and unfavorable correlation of the physiological state, non-specific resistance and adaptive capacities of carp larvae, calves and rumen microbiota in the postnatal period according to the separate action of the thermal factor, the conjugate action of the thermal factor with sound and the conjugate action of the thermal factor with the mineral premix "PMVAS".

**The theoretical significance.** Theoretical significance consists in establishing the variability of the physiological state and the response of the organism of poikilothermic and homeothermic animals to the action of abiotic environmental factors of a moderate stressogenic intensity, determining the essential role of the cellular and humoral factor on the physiological state, non-specific resistance and adaptive capacities of the animal organism in the early postnatal period; the role of cortisol in triggering stress reactions and the significance of the rumen microbiota.

**The applicative value.** The applied value of the work consists in improving the well-being of the body of carp larvae (*Cyprinus carpio*) and calves, intensifying the maturation of dominant systems and organs, increasing the non-specific resistance and adaptive capacities of the body in the early postnatal period through the directed and separate application of abiotic environmental factors of a moderate stressogenic intensity and of the biologically active compounds of the mineral premix "PMVAS".

**Implementation of the results.** The results of the study were implemented in the research activity of the Institute of Physiology and Sanocrinology, in the didactic process, in the activity of the SE „Grădina Zoologică din Chişinău” and in the process of developing normative acts.

## ADNOTARE

**La teza cu titlul „Particularitățile capacităților adaptive și rezistenței larvelor de crap și viștelor în funcție de influența factorilor de mediu” înaintată de către candidatul Balacci Serghei pentru conferirea titlului științific de doctor în științe biologice la specialitatea 165.01. Fiziologia omului și animalelor, Chișinău, 2024.**

**Structura tezei.** Teza constă din introducere, 6 capitole, concluzii și recomandări, 255 titluri bibliografice, 134 pagini cu text de bază, 13 figuri și 57 tabele. Rezultatele obținute sunt publicate în 44 lucrări științifice cu volum total de circa 42 coli de autor.

**Cuvinte cheie:** larve de crap, viștei, factori de mediu abiotici, temperatură, sunet, premix mineral, adaptare, rezistență, stres.

**Scopul lucrării.** Evaluarea acțiunii separate și conjugate a factorilor de mediu abiotici de o intensitate stresogenă moderată asupra vitalității și statutului morfofuncțional al organismului larvelor de crap (*Cyprinus carpio*) și viștelor în ontogeneza postnatală timpurie.

**Obiectivele cercetării.** Cercetarea acțiunii diferitor regimuri de temperaturi scăzute de o intensitate stresogenă moderată asupra larvelor de crap; evaluarea stării funcționale, rezistenței și capacităților adaptive ale organismului viștelor în ontogeneza postnatală timpurie în funcție de: -acțiunea temperaturii scăzute de o intensitate stresogenă moderată, aplicată separat și conjugat cu sunetul de o intensitate stresogenă moderată, - studierea acțiunii premixul mineral „PMVAS”, aplicat separat și conjugat cu temperatura scăzută de o intensitate stresogenă moderată.

**Noutatea și originalitatea științifică.** Pentru prima dată s-a studiat corelația particularităților statutului morfofuncțional al larvelor de crap și viștelor la acțiunea factorilor diferențiați de mediu de o intensitate stresogenă moderată în ontogeneza postnatală timpurie. S-a stabilit o corelație direct proporțională a răspunsului organismului animalelor poichiloterme și homeoterme la acțiunea temperaturii de o intensitate stresogenă moderată. S-a demonstrat, că acțiunea separată a factorilor de mediu abiotici influențează benefic starea fiziologică, rezistența nespecifică și capacitatea adaptivă a organismului viștelor în ontogeneza postnatală timpurie, iar acțiunea conjugată a acestui factor cu sunetul de o intensitate stresogenă moderată și de scurtă durată, acționează nefavorabil, deoarece acești factori își amplifică reciproc amplitudinile stresogene. S-a determinat influența compușilor biologic activi ai premixului mineral „PMVAS”, administrat separat și conjugat cu factorul termic de o intensitate stresogenă moderată asupra ameliorării stării fiziologice, sporirii rezistenței nespecifice și capacităților adaptive ale organismului viștelor în ontogeneza postnatală timpurie și echilibrării microbiotei rumenului.

**Problema științifică soluționată** constă în determinarea corelației favorabile și nefavorabile a stării fiziologice, rezistenței nespecifice și capacităților adaptive ale larvelor de crap, viștelor și microbiotei rumenului în perioada postnatală în funcție de acțiunea separată a factorului termic, acțiunea conjugată a factorului termic cu sunetul și acțiunea conjugată a factorului termic cu premixului mineral „PMVAS”.

**Semnificația teoretică** constă în stabilirea variabilității stării fiziologice și a răspunsului organismului animalelor poichiloterme și homeoterme la acțiunea factorilor de mediu abiotici de o intensitate stresogenă moderată, determinarea rolului esențial al factorului celular și umoral asupra stării fiziologice, rezistenței nespecifice și capacităților adaptive a organismului animal în perioada postnatală timpurie; rolului cortizolului în declanșarea reacțiilor stresogene și semnificației microbiotei rumenului.

**Valoarea aplicativă** constă în ameliorarea bunăstării organismului larvelor de crap (*Cyprinus carpio*) și viștelor, intensificarea maturizării sistemelor și organelor dominante, majorarea rezistenței nespecifice și capacităților adaptive ale organismului în perioada postnatală timpurie prin aplicarea dirijată și separată a factorilor de mediu abiotici de o intensitate stresogenă moderată și a compușilor biologic activi ai premixului mineral „PMVAS”.

**Implementarea rezultatelor științifice.** Rezultatele studiului au fost implementate în activitatea de cercetare a Institutului de Fiziologie și Sanocreatologie, în procesul didactic, în activitatea ÎM „Grădina Zoologică din Chișinău” și în procesul de elaborare a actelor normative.

## АННОТАЦИЯ

**Диссертация «Особенности адаптационных способностей и резистентности личинок карпа и телят в зависимости от влияния факторов окружающей среды», представленная Балакчи Сергей на соискание степени доктора биологических наук по специальности 165.01. Физиология человека и животных, Кишинэу, 2024 год.**

**Структура диссертации:** введение, 6 глав, выводы, практические предложения, библиография из 255 источников, 134 страниц основного текста, 13 рисунков, 57 таблиц. Полученные результаты отражены в 44 научных работах, объемом 42 авторских листов.

**Ключевые слова:** личинки карпа, телята, стресс, температура, звук, минеральный премикс, абиотические факторы среды, адаптация, резистентность.

**Цель исследований.** Определение влияния отдельного и комплексного действия абиотических факторов среды, умеренной стрессогенной интенсивности на жизнеспособность и морфофункционального статуса организма личинок карпа (*Cyprinus carpio*) и телят в раннем постнатальном онтогенезе.

**Задачи исследований.** Определить влияние различных низкотемпературных режимов умеренной стрессогенной интенсивности на личинки карпа; определить функциональное состояние, резистентность и адаптационные способности телят, в раннем постнатальном онтогенезе, исходя из: - влияния низкой температуры, применяемой отдельно и в сочетании со звуком; - изучения влияния минерального премикса «PMVAS», применяемого отдельно и в сочетании с низкой температурой.

**Научная новизна и оригинальность.** Исследованы корреляция особенностей морфофункционального статуса личинок карпа и телят и дифференцированное воздействие факторов среды умеренной стрессогенной интенсивности в постнатальном онтогенезе. Установлена корреляция организма пойкилотермных и гомойотермных животных на влияние температуры умеренной стрессогенной интенсивности. Показано, что отдельное влияние абиотических факторов среды оказывают положительное воздействие на физиологическое состояние, неспецифическую резистентность и адаптационные способности телят, а комплексное действие температуры и звука оказывает отрицательное влияние, поскольку эти факторы взаимно усиливают свои стрессогенные амплитуды. Определено влияние биологически активных веществ премикса «PMVAS», применяемого отдельно и комплексно с температурой умеренной стрессогенной интенсивности на физиологическое состояние, резистентность и адаптационные способности телят, а также на количественные и качественные показатели микробиоты рубца.

**Решенная научная проблема.** Определена благоприятная и неблагоприятная корреляция интенсивности и продолжительности применения абиотических факторов среды и премикса «PMVAS» на физиологическое состояние, защитные способности, адаптацию и резистентность личинок карпа и телят в постнатальном периоде.

**Теоретическое значение.** Установлена изменчивость физиологического состояния и ответа различных доминантных систем, в зависимости от возраста организма пойкилотермных и гомойотермных животных, на действие абиотических факторов среды, умеренной стрессогенной интенсивности в раннем постнатальном периоде.

**Практическая значимость работы** заключается в улучшении здоровья организма, интенсификации созревания доминантных систем, повышении защитных и адаптационных способностей и резистентности личинок карпа и телят в раннем постнатальном периоде под воздействием абиотических факторов среды и минерального премикса «PMVAS».

**Внедрение научных результатов.** Полученные результаты внедрены в научно-исследовательскую деятельность Института физиологии и санокреатологии, в программу учебного процесса, в деятельность МП «Кишиневский Зоопарк» и в процесс разработки нормативных актов.

**BALACCI Serghei**

**THE PECULIARITIES OF THE ADAPTIVE CAPACITIES  
AND RESISTANCE OF CARP LARVAE AND CALVES  
DEPENDING ON THE INFLUENCE OF  
ENVIRONMENTAL FACTORS**

**165.01. Human and animal physiology**

**Abstract of the doctoral thesis in biological sciences**

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