

SEPARATE AND JOINT ACTION OF ENVIRONMENTAL FACTORS ON THE ADAPTIVE CAPACITIES OF CALVES

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Abstract. The present study presents the results of the separate action of low temperature of a moderate stress intensity and its joint action with sound on some indices of the natural resistance and adaptive capacities of calves in the early postnatal ontogeny carried out in order to determine the parameters that can be used as a stimulus in beneficial conditioning of homeostasis, resistance and adaptive capacities of animals to the action of environmental factors. Thus, it has been determined that the value of the phagocytic activity in calves from the experimental groups in both experimental series is higher compared to its value in the reference groups. The same development dynamics is also demonstrated by the bactericidal activity. Lysozyme increases both in the experimental group in which temperature was applied (EGT) and in the experimental group in which temperature and sound were applied (EGTS), but in EGTS this increase is more uniform. Cortisol increases dynamically towards the 30th day in the experimental groups, but in EGTS its increase is more obvious than in EGT. As a result of the solitary application of the thermal factor of a moderate stress intensity on the body of the calves, a beneficial action regarding the body weight is recorded throughout the study period (27 days) compared to the reference group and it was 6.0 kg, which corresponds to 222 g daily gain. Following the combined application of the low temperature with the sound of a moderate stress intensity on the body of the calves, a beneficial increase in the body mass of the calves from the experimental group compared to the reference group is initially observed, which subsequently decreases and at the age of 30 days the body weight of the calves from the experimental group is lower than the weight of the reference group calves. Thus, we can note that the combined action of low temperature and sound of a moderate stress intensity on calves in the early postnatal period has a beneficial effect on some indices of natural resistance such as phagocytic activity, bactericidal activity and lysozyme, but does not have a beneficial effect on body mass growth (a quantitative index of productivity).

Keywords: calf, postnatal ontogeny, temperature, sound, stress.

Rezumat. Acțiunea separată și conjugată a factorilor de mediu asupra capacităților adaptive ale vițelilor. Studiul de față prezintă rezultatele acțiunii separate a temperaturii scăzute de o intensitate stresorică moderată și conjugată ale acesteia cu sunetul asupra unor indici ai rezistenței naturale și capacităților adaptive ale vițelilor în ontogeneza postnatală timpurie efectuat în scopul determinării parametrilor care pot fi folosiți ca stimulente în condiționarea benefică a homeostaziei, rezistenței și capacitățile adaptive ale animalelor față de acțiunea factorilor de mediu. Astfel, s-a determinat că valoarea activității fagocitare la vițelii din loturile experimentale din ambele serii experimentale este mai mare în comparație cu valoarea acesteia din loturile martor. Aceiași dinamică de dezvoltare demonstrează și activitatea bactericidă. Lizozima crește atât în lotul experimental în care a fost aplicată temperatura (LET), cât și în lotul experimental în care s-a aplicat conjugat temperatura cu sunetul (LETS), dar în LETS creșterea este mai uniformă. Cortizolul crește în dinamică spre ziua a 30-a în loturile experimentale, dar în LETS creșterea acestuia este mai evidentă decât în LET. În urma aplicării solitare a factorului termic de o intensitate stresorică moderată asupra organismului vițelilor se înregistrează o acțiune benefică a greutateii corporale pe toată perioada de studiu (27 zile) în comparație cu lotul martor și a constituit 6,0 kg, ceea ce corespunde cu 222 g spor diurn. În urma aplicării conjugate a temperaturii scăzute cu sunetul de o intensitate stresorică moderată asupra organismului vițelilor inițial se constată o creștere benefică a masei corporale a vițelilor din lotul experimental față de lotul martor, care ulterior scade și la vârsta de 30 zile este inferioară greutateii vițelilor din lotul martor. Astfel, putem să remarcăm faptul că acțiunea conjugată a temperaturii scăzute și a sunetului de o intensitate stresorică moderată asupra vițelilor în perioada postnatală timpurie acționează benefic asupra unor indici ai rezistenței naturale precum sunt activitatea fagocitară, activitatea bactericidă și lizozima, dar nu acționează benefic asupra creșterii masei corporale (indice cantitativ al productivității).

Cuvinte cheie: vițel, ontogeneza postnatală, temperatură, sunet, stres.

INTRODUCTION

Environmental (ecological) factors affect the organism in most cases in combination and the effect of the action depends on their nature and intensity (HOTETEŢU, 2011; EGOROV & KHABAROV, 2016; MEDVEDEV & SOKOLOVA, 2019; PLYASHCHENKO & SIDOROV, 1987; GOLOKHVAST & CHAIKA, 2011). Moreover, the effects that occur after their separate or combined action are different and are seen in the depth of changes in physiological processes, that determine the development and growth of the organism (BROUČEK, 2014; ***, Directive, 2002; FURDUI, 1986). In higher organisms, atmospheric air temperature is considered an abiotic physical factor of the environment with the greatest impact, both directly and indirectly, because it determines the thermal energy changes that occur in all the basic biochemical reactions of any organism (BOGOMOLOVA et al., 2014; GLAGOLEVA, 2015; ZELPER & SOLOVIKH, 1974; IVANTER, 2010. CHEGINA, 1993). Its influence forces the body to keep its adaptive mechanisms ready, contributing to the constant maintenance of homeostasis within the limits of physiological normality according to temperature fluctuations (CARDOSO et al., 2015; GOLUBINA & FILOCHENKO, 1990). Another environmental factor is sound, which until recently was considered an abiotic environmental factor and was ignored by the scientific community as an object of study in scientific experiments, because it practically did not present a discomfort to both humans and animals. Currently, due to human activities, it is

becoming stronger and is perceived by living organisms as an ecological stress factor and can be classified as an anthropogenic environmental factor (EGOROV & KHABAROV, 2016).

Since temperature acts in combination with other environmental factors, it is currently of interest to carry out research in order to study the combined effect of low temperature with the sound of moderate stress intensity on the functional state, resistance and adaptive capacities of the organism in the early postnatal ontogenesis and to determine the parameters that can be used as a method of increasing the resistance and adaptive capacities of the animal organism against the adverse effects of the environment (DAS et al., 2016; LORENZ et al., 2011; PUSTA, 2006; BOCHAROV, 2015; GOLUBINA & FILOCHENKO, 1990; KURDEKO et al., 2017).

In the carried out research, the influence of the combined effect of low temperature with the sound of moderate stress intensity on calves in the early postnatal ontogenesis was studied according to the periodization developed by the Institute of Physiology and Sanocreatology of the Republic of Moldova in critical periods of development: imprinting, reaction depression stressful, immunodeficiency, as well as the beginning of periods of dominance and retardation of the rate of growth, functioning and development of organ systems. In accordance with the scheme of the proposed experiments, the indices of cellular and humoral resistance were investigated, as well as cortisol as an index of the organism's reactivity to stress factors.

MATERIAL AND METHODS

The experiments carried out for the purpose of studying the separate effect of the thermal factor (1st series of experiments) and the combined effect of the thermal factor with the acoustic one (2nd series of experiments) were carried out on calves of the black and white breed in strictly regulated conditions of the "Zootron" climate chamber. The calves trained in the experiments were selected according to the principle of analogy, taking into account age, sex and body mass. In each series of experiments, two groups of animals were formed, the control group (CG) and the experimental group (EG) with 10 heads each.

The effect of the thermal factor of moderate stress intensity was tested on the animals of the experimental group of the 1st series of experiments. The temperature of +5 °C was applied as a stress factor. After introducing the animals into the "Zootron" climate chamber and adapting them for 1 hour to the new conditions, the temperature in the climatic chamber decreased to +5 °C. The temperature decrease was achieved gradually during 30 minutes. The application of the low temperature of a moderate stress intensity on the calves was carried out during the postnatal ontogenesis at the age of 3, 8, 15, 20, 25, and 30 days. The exposure to the thermal factor at the age of 3, 8 and 15 days lasted 1 hour, and at the age of 20, 25 and 30 days lasted 2 hours.

The animals in the experimental group of the 2nd series of experiments were tested for the low temperature effect of a moderate stress intensity of +5 °C applied according to the scheme described in the 1st series of experiments. Additionally, 70-80 db sound was applied to the animals of the experimental group. The sound of 70-80 db was applied 3 times for 5 minutes with 25 minute intervals at the age of 3, 8, 15 days. At the age of 20, 25 and 30 days the sound was applied 3 times for 10 minutes with intervals of 45 minutes. The combined application of the studied stress factors was carried out during the postnatal ontogenesis at the age of 3, 8, 15, 20, 25 and 30 days.

Blood samples were collected from the jugular vein of calves immediately after the application of the study factors and subsequently processed according to reference biological methods.

In accordance with the proposed scheme of the experiment, the following indices of natural resistance were investigated: phagocytic activity (according to Gostev), bactericidal activity (according to Matusevici), lysozyme (by the photo-electrocolorimetric method) and cortisol (by the radioimmunological method) (KONDRAKHIN et al., 2004). The statistical processing of the results was carried out in accordance with the variable statistical laws and probability theory. During the statistical processing of the obtained data, special attention was paid to determining the validity of the difference between the comparative values. The main conclusions of the article are based on the statistically significant differences between the control and experimental groups. The results are expressed as the mean value \pm standard error. The shown significance threshold is $P < 0.05$ (IVANTER, 2010).

RESULTS AND DISCUSSION

In order to study the resistance and adaptive capacities of the calves in early postnatal ontogenesis, the phagocytic activity in the blood serum was investigated. The results obtained after the effects of low temperature of a moderate stress intensity and the combined action of low temperature with the sound of a moderate stress intensity are shown in Fig. 1.

The data in Fig. 1A demonstrate that in the experimental group of the series in which the calves were subjected to the action of the low temperature of a moderate stress intensity, the phagocytic activity was higher than its value in the control group throughout the duration of the study. The same tendency of increased phagocytic activity was also recorded in the series in which the acoustic factor was additionally applied.

When analyzing the dynamics of the phagocytic activity both before and after the application of the stress factors in both experimental series, a decrease was recorded after the 8th day ($P < 0.05$), and remained at this level until the age of 30 days which corresponds to the data of the specialized literature (GLAGOLEVA, 2015; LYSOV et al., 2004; SAMBUROV & PALAUS, 2014).

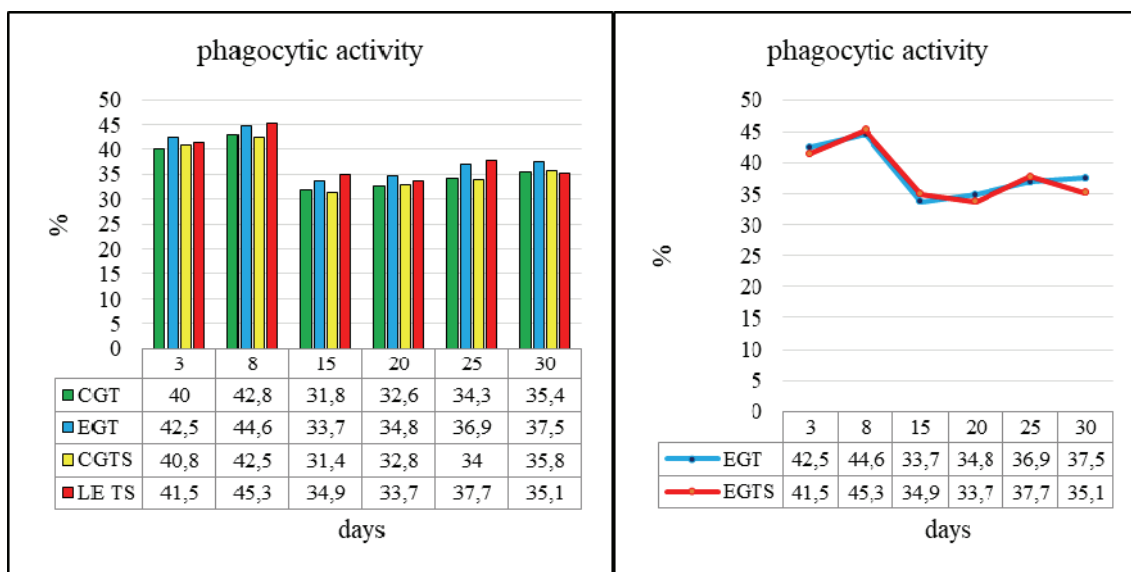


Figure 1. Indices of phagocytic activity in calves subjected to the action of low temperature of a moderate stress intensity and to the combined action of low temperature with the sound of a moderate stress intensity.

Note: here and further

CGT - the control group of the series in which the temperature was applied;

EGT - the experimental group of the series in which the temperature was applied;

CGTS - the control group of the series in which temperature + sound was applied;

EGTS - the experimental group of the series in which temperature + sound was applied.

At the same time, it was found that the dynamics of phagocytic activity showed an oscillatory character (Fig. 1B) throughout the study period when the studied environmental factors were applied alone or in combination on the body of the calves in the early postnatal period.

Further, the comparative analysis of the humoral activity indices of the body of calves was carried out. The data obtained regarding the bactericidal activity are presented in Fig. 2.

The data included in Fig. 2A demonstrate the fact that regardless of the group and the experimental series, the bactericidal activity increases from the age of 3 days of the calves to the age of 30 days and is consistent with the data of the specialized literature (VELIKANOV et al., 2020; SAMBUROV & PALAUS, 2014). At the same time, it is noted that its value is higher in the experimental groups as compared to the value of the bactericidal activity in the control groups. In addition, it can be noted that the evolution of the bactericidal activity of the blood serum in calves in the group where a single stress factor (temperature) was applied increased uniformly ($P < 0.05$).

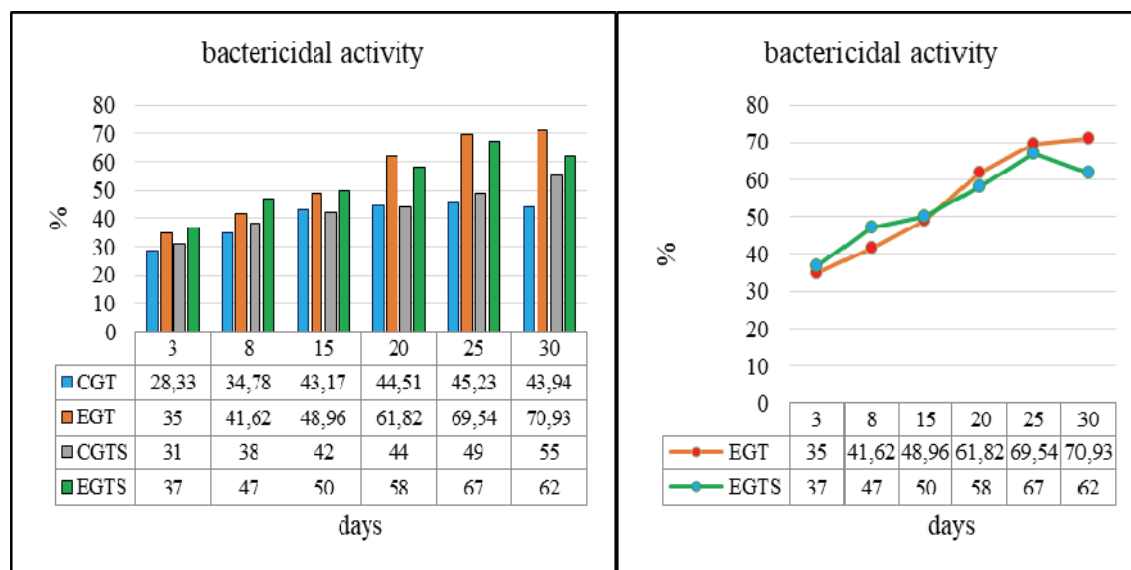


Figure 2. Indices of bactericidal activity in calves subjected to the action of low temperature of a moderate stress intensity and to the combined action of low temperature with the sound of a moderate stress intensity.

At the age of 30 days, the bactericidal activity exceeded its value in the blood of calves of the experimental group in which temperature with the sound were applied as stress factors. The bactericidal activity uniformly increased in the experimental series in which the ecological factors of the environment were applied in conjunction ($P < 0.05$), (Fig. 2B). At the same time, we can note that, at the age of 3 and 8 days, the bactericidal activity in EGTS was higher than in EGT. Later, its values at the age of 15 days were practically equalized (EGT-48.96%, EGTS-50.0%), after which a decrease in bactericidal activity in EGTS compared to EGT was recorded until the end of the experiment.

The next humoral resistance factor that has been subjected to comparative analysis is lysozyme. The research data are presented in Fig. 3.

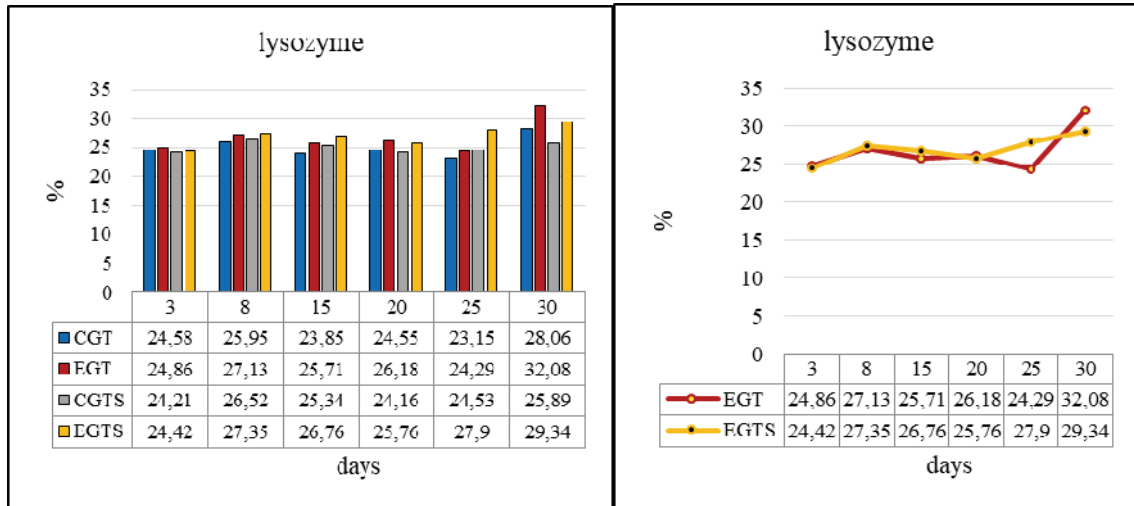


Figure 3. Lysozyme indices in calves subjected to cold temperature of moderate stress intensity and cold temperature combined with the sound of moderate stress intensity.

From the data in Fig. 3A, it can be observed that the lysozyme value in both experimental groups where the stress factors were tested was higher as compared to the lysozyme value in the control groups throughout the study period ($P < 0.05$). The dynamics of lysozyme in EGTS is more uniform with a slight increase by the 30th day (Fig. 3B). At the same time, it is noted that the amount of lysozyme in the initial EGT increased, then by the 25th day it decreased and was practically equal to its amount on the 3rd day, after which a significant increase was recorded at the age of 30 days ($P < 0.05$).

Therefore, the stress factors applied to the body of calves in early postnatal ontogenesis, either separately or in combination, stimulated the increase of lysozyme in blood serum.

The evolution of the amount of cortisol under the action of low temperature of a moderate stress intensity and the combined action of low temperature with the sound of a moderate stress intensity on the calves is presented in Fig. 4.

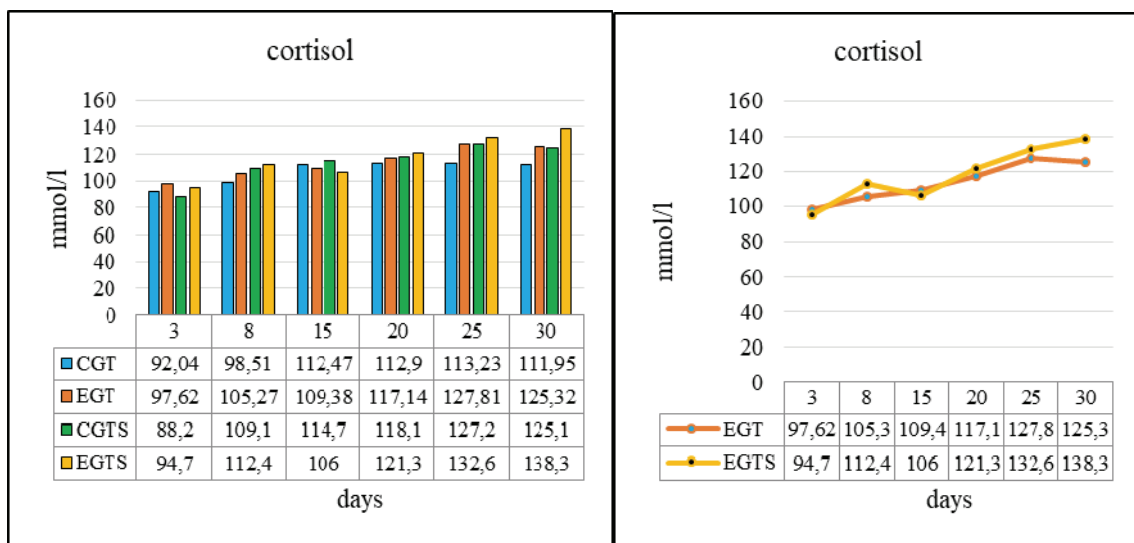


Figure 4. Cortisol indices in calves subjected to the action of low temperature of a moderate stress intensity and to the combined action of low temperature with the sound of a moderate stress intensity.

Based on the data of Fig. 4A it can be noted that the amount of cortisol in both experimental series increased compared to its amount recorded in 3-day-old calves. At the same time, the cortisol value in calves of the experimental groups was higher than its value in calves of the control groups (except for the 15th day). In the comparative analysis of the cortisol data (Fig. 4B) after the application of the stress factors, we note that it increased in the EGT from the age of 3 days (97.62 ± 2.99 mmol/l) to the 25th day (127.81 ± 3.10 mmol/l), ($P < 0.05$) after which a decrease in its value was recorded (125.32 ± 3.41 mmol/l). At the same time, in the EGTS a similar decreasing tendency was registered at the age of 15 days after which a uniform increase was observed until the 30th day ($P < 0.05$).

Thus, although the cortisol value at the age of 3-day calves of EGTS (92.7 ± 2.84 mmol/l) was lower than the cortisol value at the age of 3-day calves of EGT (97.62 ± 2.99 mmol/l), it increased during the experiment and at the age of 30 days exceeded the cortisol value of EGT ($P < 0.05$). In the context of this study, we would like to note that the large amount of cortisol caused a greater stress reaction of the body to the combined action of the stress factors compared to their solitary action.

Later, the increase in the body mass of the calves subjected to the separate and combined action of the surveyed environmental factors was studied. The obtained results are presented in Fig. 5.

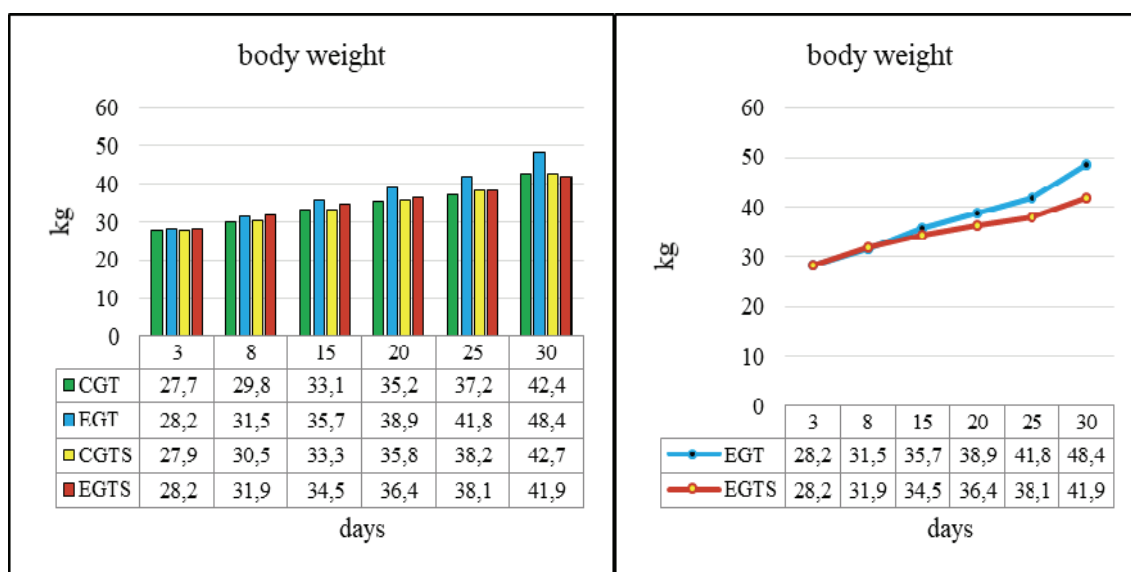


Figure 5. The growth rate of calves subjected to the action of low temperature of a moderate stress intensity and to the combined action of low temperature with the sound of a moderate stress intensity.

When forming the experimental groups, the principle of analogy was respected, thus, at the beginning of the study, the body weight of the calves of both groups of the experimental series was basically the same (Fig. 5A) and was within the limits of 27.7 ± 0.78 kg up to 28.2 ± 0.73 kg.

From the data in Fig. 5A, it can be seen that in the experimental series where only the thermal factor was applied, the body weight of calves of EGT was higher than the weight of calves of CGT. This increase is more pronounced at 20, 25 and 30 days of age ($P < 0.05$). In the series of experiments in which the combined action of environmental factors was studied, the dynamics of body weight in the first periods of life was similar to that in the first series of experiments. Then, on the 20th day, they basically equalized in both groups (CGTS-35.8 kg, EGTS-36.4 kg). Later, at the age of 25 and 30 days, the weight of calves of the experimental group (41.9 kg) was lower than the weight of calves of the control group (42.7 kg).

When analyzing the body weight after the application of the stress factors it was observed that the body weight of calves in EGT was higher than in EGTS (Fig. 5B) ($P < 0.05$).

CONCLUSIONS

The value of phagocytic activity in calves of the experimental groups in both experimental series is higher compared to its value in the control groups. The same development dynamics also demonstrates the bactericidal activity. Lysozyme increases in both EGT and EGTS, but in EGTS this increase is more uniform. Cortisol increases in dynamics by the 30th day in the experimental groups, but in EGTS its increase is more obvious than in EGT. After the solitary application of the thermal factor of a moderate stress intensity on the body of the calves, a positive effect of the body weight was recorded throughout the study period (27 days) compared to the control group and amounted to 6.0 kg, which corresponds to 222 g of daily gain. After the combined application of the low temperature with the sound of a moderate stress intensity on the body of the calves, a beneficial increase in the body mass of the calves was seen in the experimental group compared to the control group, which subsequently decreased and at the age of 30 days was lower

than the weight of the calves of the control group. Thus, we can note that the combined action of low temperature with the sound of moderate stress intensity on calves in the early postnatal period has a beneficial effect on some indices of natural resistance such as phagocytic activity, bactericidal activity and lysozyme, but it has an unfavourable effect on the increase of the body mass as a quantitative index of productivity.

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