
The functional status, resistance and adaptive capacities of the calves being affected by combined stressors during their early postnatal ontogenesis

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Abstract

The experimental studies revealed and analyzed the dynamics, protein and saline metabolism, resistance to stress factors and adaptive capacities (total proteins and protein fractions, urea, macro elements Ca, P, Na, K, content of glucose, bactericide activity, cortisol concentration) of calves in their early postnatal ontogenesis under the combined influence of stresogen thermal maintenance factor, noise and parasitic factors. There were established that the fluctuations of the researched physiological parameters have the phasic character. The tested indices, in major cases were quantitatively lower in the group of animals affected by the combined stressor factors. Two ascends in changing of the indices have been observed: at the 7-8-th and at the 25-30-th days at birth that coincided with critical development periods: immunodeficiency, depression of the stresogen reaction, depression of dominance and retardation. The positive effect has been registered also upon stress resistance and adaptation capacities of the organism.

Key words: cattle, resistance and adaptive capacities, parasitar factors.

Introduction

The environmental factors (optimal, stressors, extremal) have an effect on organism in multiple situations of combination of such and the impact of their application depends on its nature and intensity (Furduy F. I. and others, 1982, 1985, 1992).

According to data reflected in scientific literature, the complex of factors applied simultaneously in most cases cause aggravation of the deviations of the functional status of the organism, compared to their separated application, especially in the critical periods of early ontogenesis (Dobrovol'skiy L. A., 1982; Furduy F. I. and others, 1985; Erhan D. C. etc., 2007; Pavaliuc P. P. etc., 2012).

At the same time, the influence of the simultaneous combined factors can be favorable and the effects of the applied combined environmental factors may be of these three types: additive, synergetic and antagonistic. This classification reflects the essence of the effects that could be observed while factors of various nature affect the organism (Antipjv V. V. and others, 1980; Furduy F. I. and others, 1985; Erhan D., Pavaliuc P., Rusu Ș., 2007; Rusu Ș., 2012).

The specialized scientific literature lack data on effects of the combined action of the maintenance stressor factors on the organism of calves during their early postnatal ontogenesis. The presented study has been targeting on establishment of the functional status, resistance and adaptive capacities of calves in their early postnatal ontogenesis while affected with stressor thermal maintenance factor being combined with other stressors such as excessive noise and parasitic factors.

Materials and methods

The research has been undertaken on calves of Black-and-White Holland race during their early postnatal ontogenesis and under controllable conditions. On the leash, similarly to the

conditions of households where intensive technologies usually applied, the temperature, noise and parasitic factors are the most predominant one that provoke stress in animals. The thermal factor of the stressful intensity combined with a noise of 70-80 db and parasitic agents (*Eimeria spp.*, *Strongyloides papillosus*) have been applied to calves following the research purpose.

The animals have been placed in the climacteric camera allowing them to adapt to the new conditions during 40-60 minutes, and afterwards the temperature have been decreased up to 5^oC. The stressing temperature combined with noise has been applied on 3-rd, 8-th, 15-th, 20-th, 25-th and 30-th days at birth.

The blood has been collected from the adapted animals just before and after applying combined stimuli. The traditional methods of data processing have been used for the analysis of the collected material. The following blood indices have been researched: the content of total proteins, protein particles, glucose, alkaline reserve, Ca, P, Na, K-levels, cortisol, bactericide activity as well as the growth rate values. The values of the physiological indices studied before applying combined stimuli have been serving as the control set (control group).

Results and discussions

The previous scientific studies revealed the specifics of influence of the stressing thermal maintenance factor on the functional status, resistance and adaptive capacities of calves during their early postnatal ontogenesis (Pavaliuc P., Erhan D., Rusu Ş. et al., 2012).

An special interest represents the results of the research when stressing temperature is applied along with another such widespread in households' factor as noise. The carried out experiments allowed studying the functional status, resistance and adaptive capacities of the organism of calves during their early postnatal ontogenesis while affected by combined stressor maintenance factors such as temperature and noise. The obtained results are presented in Table 1.

The analysis of obtained data shows that the complex effect of thermal and noise factors at 3-rd and 8-th days at birth, the concentration of total proteins have not been affected considerably compared to its indices before the influence of stressor factors, so that only at the 15-th day this have been increased by 6,5%, and at the 20-rth - by 8,5%, at the 25-th day- by 9,9%, and at 30-th day at birth - by 19%, as compared to the control group. There should be mentioned the relatively stable character of the concentration of blood proteins and its non-essential increase after applying combined stressors under maintenance condition as compared to the control group.

The analysis of the concentration of the protein particles revealed that the concentration of blood albumins has been decreased by 14,0% and by 10,4% correspondingly after applying combined stressors at 8-th and 15-th days at birth as compared to the control group. Just after the 20-th day the increase (by 38,4%) has been observed that reached the maximum level at the 25-th day as compared to the control group. While applying the stressor factors at the 8th day of birth the decrease of the concentration of α -globulins by 2,9 times, and at 25-th day - by 2,3 times has been noted. In this way, the dynamics of changing's in protein particles in calves during their early postnatal ontogenesis is characterized by the decrease of concentration of α -globulins during its first period. Further on, after 15-th day one can observe an increase, especially at the 30-th day. An increase in concentration of β - and γ -globulins at 8-th day, especially of β -globulins (by 1,9 times) have been observed, less marked for γ -globulins (by 1,2 times). Under the influence of combined maintenance stressor factors, the level of β -globulins in blood at the 25-th day at birth has decreased by 1,3 times as compared to its values in control group, and the level of γ -globulins remained approximately at the same level as it was before applying the stressor factors.

While applying the combined stimuli the concentration of urea have been increased prominently only at 25-th and 30-th days (by 49,3 and 20,3% correspondingly). The similar

increase has been observed also before applying these. This increase could be explained by the introducing after 20-th day in the animal ration of the complex food (hay, haulage).

This being said, one can observe the tendency of the increase of the level of the total proteins starting with 15-th day and the level of urea – starting with 25-th day. The limits of evaluation of these indices have been relatively stable. The level of changing's in the protein particles to a great extent has been correlated with the level of changing's in the total proteins.

Another important physiological indices that characterize the functional status of the organism is the level of saline metabolism that could be explained by determining the concentration of macro elements (Ca, P, Na, K) in the blood, and their correlations (Ca:P; Na:K).

Table 1. The dynamics of the protein metabolism indices researched during early postnatal ontogenesis of calves affected in maintenance conditions by combined impulsive thermal and noise factors (n=10 animals)

Age (days)	Total proteins, g/l	Protein particles, %				Urea, mmol/l
		albumins	globulins			
			α -	β -	γ -	
Before the influence of stressor factors						
3	59.2±2.49	55.3±2.64	10.5±0.31	14.5±0.39	19.7±0.56	1.72±0.08
8	58.3±2.50	62.2±3.08	7.2±0.30	14.3±0.42	16.3±0.47	2.15±0.11
15	51.8±2.41	72.8±3.01	6.3±0.29	11.5±0.38	9.4±0.26	2.00±0.11
20	52.1±2.48	61.3±2.74	15.8±0.43	14.9±0.43	8.0±0.21	2.04±0.11
35	52.5±2.51	50.0±2.06	26.7±0.97	18.3±0.45	5.0±0.19	2.01±0.09
30	51.9±2.43	65.8±2.53	15.9±0.54	9.1±0.27	9.2±0.24	3.16±0.12
After the influence of stressor factors						
3	60.1±2.63	52.1±2.41	3.7±0.12	25.2±0.41	19.0±0.29	1.83±0.09
8	58.3±2.51	53.5±2.47	2.5±0.11	25.4±0.44	18.6±0.29	2.30±0.11
15	55.4±2.48	65.2±2.63	6.5±0.18	20.7±0.42	7.6±0.28	1.87±0.09
20	57.0±2.50	66.9±2.71	8.7±0.21	18.1±0.38	6.3±0.21	2.43±0.11
25	58.3±2.51	69.2±2.84	11.5±0.25	13.6±0.36	5.7±0.19	3.00±0.15
30	54.1±2.61	66.3±2.68	13.0±0.39	11.9±0.32	8.8±0.24	3.80±0.21

$P \leq 0,05$

The dynamics of the changing's in the concentration of these elements in the blood of calves during their early postnatal ontogenesis before and after applying combined stressor factors – temperature and noise under maintenance conditions-is presented in Table 2.

Similarly to situation of concentration of Ca upon applying stressor factors, the concentration of P observed an insignificant tendency of changing's that still falls into the norm limits (1,45-1,90 mmol/l). While applying the stressor factors, the correlations of these two elements have been slightly increased as compared before applying these, yet again falling into the norm limits.

The data from Table 2 reveal that the level of Na in blood of the calves affected by combined stressing thermal and noise factors have been increasing from the 3-rd to 25-th days, and its decrease have been observed in the ulterior periods of research. The content of K in blood in the

same circumstances remains almost unchanged. Thus, the obtained data show the stable character of Na' and especially of K' metabolism that could be observed from its values' dynamics.

The data from Table 2 shows that the concentration of Ca during all period of applying the combined stimuli have been higher as compared to the control group and this tendency, starting with 8-th day have been approximately corresponding to 0,2 mmol/l. At the same time, there should be mentioned the decrease in dynamics of levels of Ca, and an increase of its level at 30-th day in both groups.

Table 2. The dynamics of the saline metabolism indices in calves during their early postnatal period at influence of impulsive thermal and noise stressors (n=10 animals)

Age (days)	Ca, mmol/l	P, mmol/l	Ca:P	Na, mmol/l	K, mmol/l	Na:K
Before the influence of stressor factors						
3	2.80±0.12	1.87±0.10	1.49±0.85	155.41±5.01	6.62±0.33	23.55±1.2
8	2.60±0.11	2.07±1.11	1.26±0.78	158.64±4.63	6.83±0.29	23.32±1.2
15	2.55±0.11	1.62±0.14	1.57±0.91	152.40±5.03	5.80±0.21	26.28±1.2
20	2.47±0.90	1.58±0.08	1.56±0.72	153.3±4.94	6.44±0.27	23.95±1.2
25	2.40±0.80	1.52±0.06	1.58±0.84	154.61±5.00	7.03±0.31	22.09±1.2
30	260±0.11	1.62±0.11	1.60±0.86	150.0±5.01	6.41±0.38	23.47±1.2
After the influence of stressor factors						
3	2.83±0.12	1.90±0.12	1.49±0.90	132.73±5.20	6.33±0.28	21.06±1.1
8	2.80±0.12	1.94±0.11	1.44±0.75	139.22±5.00	6,42±0.31	21.75±1.2
15	2.75±0.11	1.74±0.09	1.58±0.83	150.61±5.11	5.71±0.17	26.42±1.3
20	2.68±0.11	1.70±0.10	1.58±0.91	152.10±4.98	6.30±0.23	22.56±1.2
25	2.60±0.90	1.64±0.08	1.59±0.87	153.40±4.57	6.84±0.30	22.56±1.2
30	2.85±0.12	1.68±0.09	1.70±0.89	147.41±4.89	6.21±0.25	23.77±1.2

P ≤ 0,05

The conducted experimental studies allowed also observing the dynamics of the level of glucose and alkaline reserve in calves' blood during their early postnatal ontogenesis while applying combined stressing thermal and noise factors. The obtained data are presented in Figure 1 and 2.

The data from Figure 1 indicate the concentration of glucose in the blood of animals at influence of impulsive thermal and noise stressors during their early postnatal ontogenesis that varied and its dynamics could be characterized by the phasic aspects. Its maximum level has been observed at 8-th and 25-th days (6,66±0,24 and 5,55±0,18 mmol/l).

Under the influence of stressing factors the concentration of glucose have been observed as increasing one during all ontogenesis periods (especially at 15-th day – nearly 2 times) excepting the 25-th day at birth when its sharp decline (by 39,6%) has been observed. These two quite pronounced peaks of changing's have been noted at the 15-th and 25-th days as compared to other periods.

Similarly, the changing's in the dynamics of the alkaline reserve (Figure 2) had the phasic character and its increased level (before and after applying stressing factors) up to 8-th day

followed by a decrease of its concentration up to the 25-th day, and a phase of increasing values (on 30-th day). There is a reciprocal correlation of the level of alkaline reserve and level of glucose in the blood. While applying the combined stressing factors at 8-th day at birth the alkaline reserve has been increasing as compared to the control group by 9,1%, and at 15-th day it declined by 22,2%, at 25-th day – by 16,6%. Finally, at 25-th day it declined 2,6 times, if compared to the levels of the 8-th day.

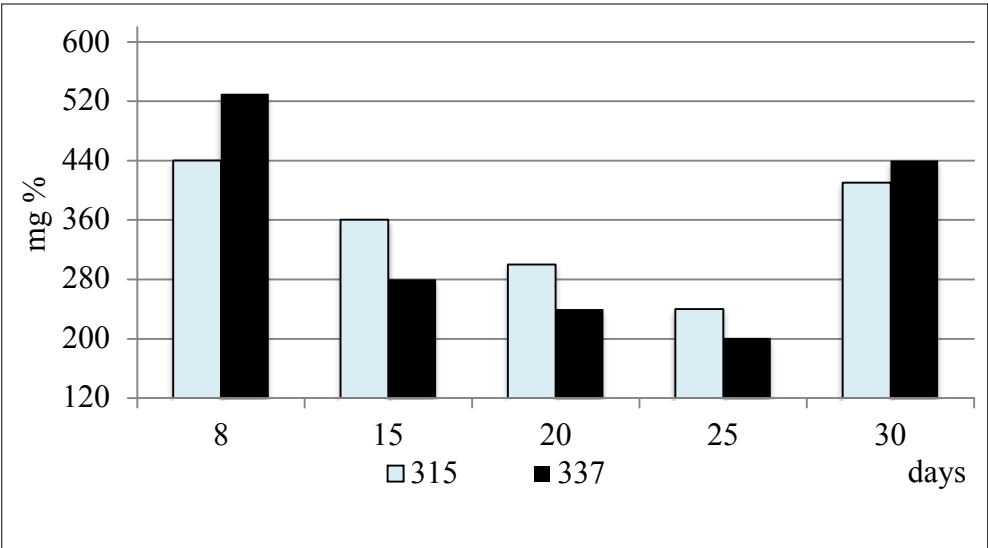


Figure 1. The concentration of glucose in blood plasma of calves during their early postnatal ontogenesis at influence of impulsive thermal and noise stressors

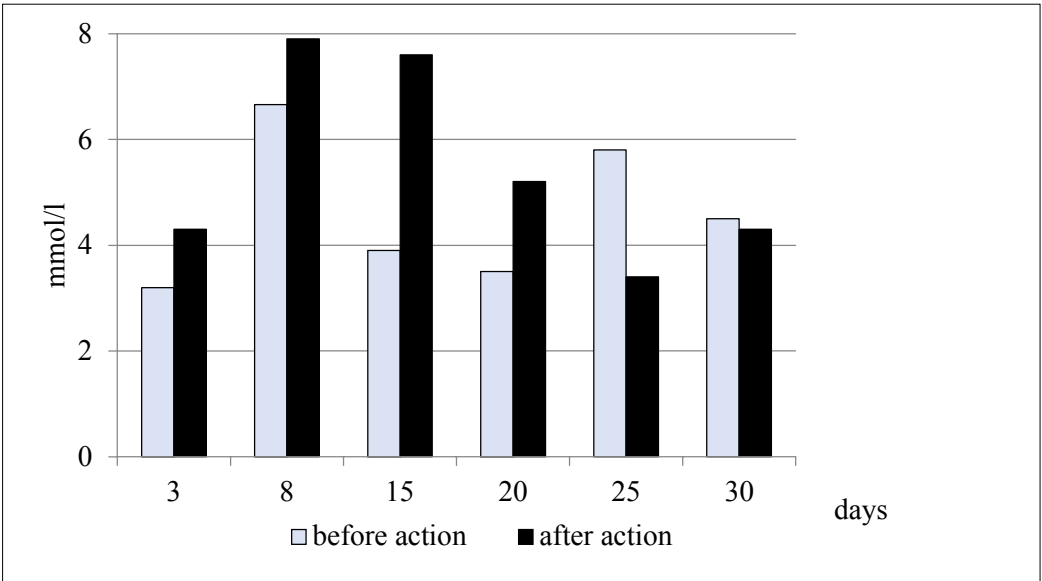


Fig. 2. The concentration of alkaline reserve of calves during their early postnatal ontogenesis at influence of impulsive thermal and noise stressors

In this way, the decrease in the level of glucose and alkaline reserve demonstrates the mobilization of the energetic resources in the organism as a response to the developed reaction to stressors. The muscular system became matured, this period being a dominant one.

Some physiological indices that characterize the resistance of the organism to the stressing factors such as bactericide activity and cortisone concentration in blood have been also studied (Figures 3, 4).

The data from Figure 3 indicate that concentration of cortisone had a tendency of slight increase excepting the 15-th day when it decreased to the level of the control group. This could be explained by the fact that the major part of maternal immunoglobulin's have already disintegrated but the own system not yet matured (period of immunodeficiency). That is why the release of hormone is intensified and its quantity is increasing gradually corresponding to the process of maturation of suprarenal capsules determining the organism to adapt to the changed environmental conditions.

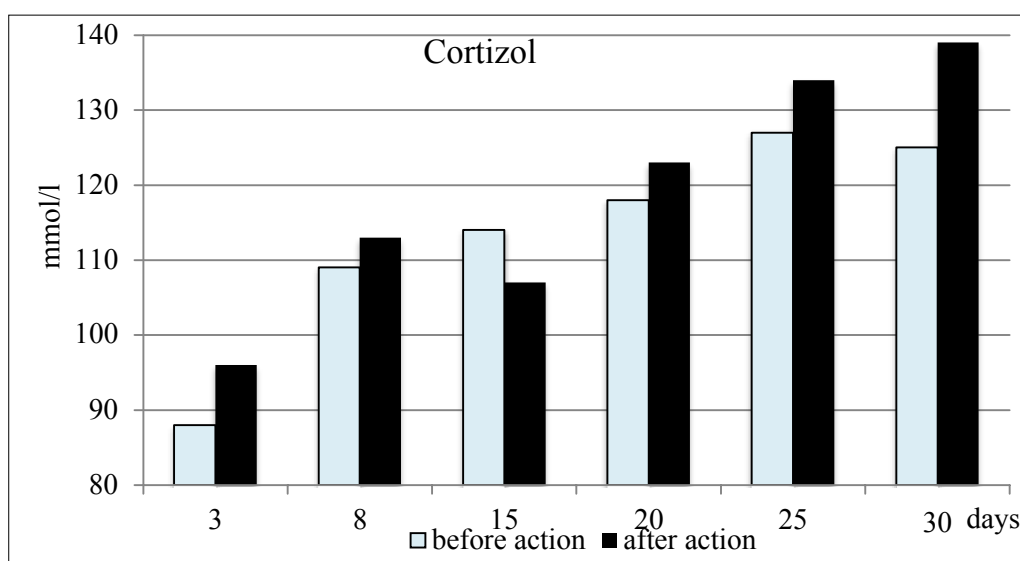


Fig. 3. The dynamics of cortisone concentration in blood of calves during their early postnatal ontogenesis at influence of combined thermal and noise stressing factors

The index that characterizes the stress, resistance and adaptive capacities of the organism to the action of the stressing factors also served the bactericide activity (Figure 4). The obtained data prove that the applying the combined stressing factors cause the increase of this index as compared to the control group, and this have been constant during all period of research constituting 23,9% in average. The biggest increase (by 36,7%) of bactericide activity, compared to the control group, have been registered at 25-th day.

The tempo of calves' growth during critical periods of early postnatal ontogenesis at influence of combined thermal and noise stressing factors have been slightly increased as compared to the control group that could be explained by the induced mobilization of plasticity and energy compensation reactions. This tempo is decreasing in the experimental group compared to the control one just after the critical periods of growth.

During previous studies the influence of stressing abiotic factors on the particularities of the functional status, resistance and adaptive capacities of the calves during their early postnatal ontogenesis have been researched as a separate issue (Pavaliuc P., Erhan D., Rusu Ș. et al., 2012).

Later on, 2 series of experiments have been carried out while testing in a separate ways the stressing factors in two groups of calves: 1) applying the combined abiotic stimuli (stressing temperature + excessive noise), the results of which are presented above; 2) control group, applying the biotic parasitic factor, by applying the combined abiotic and biotic stimuli (stressing temperature + excessive noise + parasitic factor). The obtained results are presented below in Table 3.

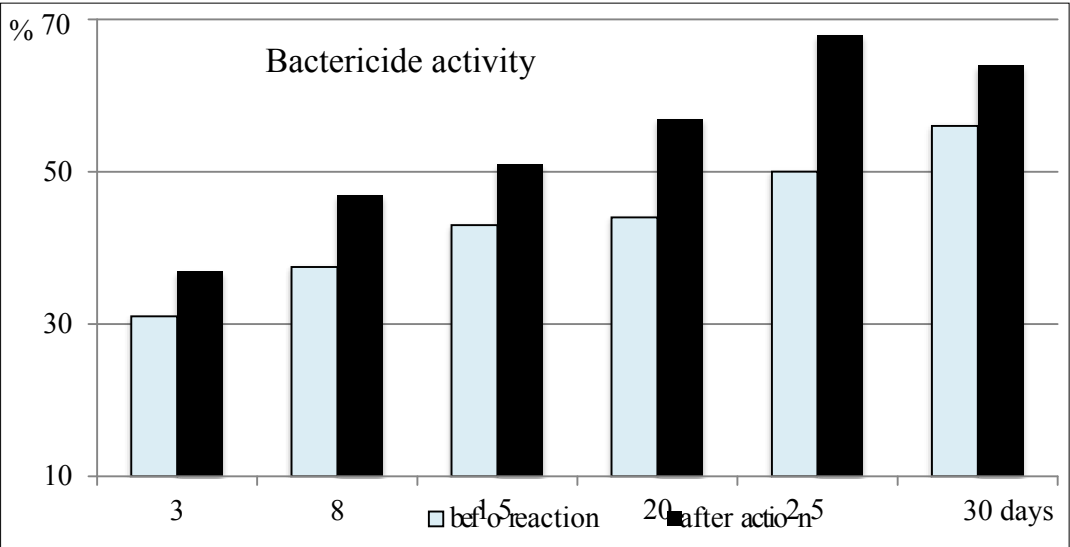


Fig. 4. The dynamics of bactericide activity in the blood of calves during their early postnatal ontogenesis at influence of combined thermal and noise stressing factors

Table 3. The indices of protein metabolism in calves during their early postnatal ontogenesis at influence of mono- and multifactorial stimuli (n=10 animals)

Age (days)	Total proteins, g/l	Protein particles, %			
		albumins	globulins		
			α -	β -	γ -
Control group					
15	59.27±2.47	62.37±2.91	11.90±0.30	14.17±0.40	13.35±0.38
After applying the parasitic factor					
15	83.33±1.41	37.65±1.70	8.55±0.40	13.70±0.8	31.50±1.25
After applying the combined stressing temperature, excessive noise and parasitic factors					
15	68.21±2.40	50.18±1.89	9.58±0.19	16.98±0.33	10.89±0.26

$P \leq 0,05$

The data presented in Table 3 indicate that the studied indices have been considerably changed in calves under the influence of the biotic parasitic as well as of the combination of abiotic and biotic stressors, as compared to the control group. The concentration of total proteins and protein particles' spectrum have been changing as follows: while applying the separate parasitic stressor – the content of albumins, α - and β -globulins have been decreased by 39,6; 28,1 and 3,3% correspondingly while the content of total proteins and level of γ -globulins have been increased by 40,6% and by 2,4 times correspondingly.

The spectrum of protein particles while applying the combined abiotic and biotic stressors has been changing in the following way: the content of albumins, α - and γ -globulins have decreased by 19,5; 19,50 and 18,4% while the total proteins and the level of β -globulins have been increased by 15,1% and 19,8%. The analysis of the obtained results reveals that the concentration of total proteins and γ -globulins in calves from the group affected with combined thermal along with excessive noise and parasitic stressors, registered a decrease of 18,1% and by 2,9 times, and the concentration of albumins, α - and β -globulins has increased by 33,3; 12,1 and 23,9% as compared to the group of animals affected with parasitic stressor only. This could be explained by the impact and way of stimuli effect on the organism of calves during their early postnatal ontogenesis.

In this way, two ascents of pronounced changes of the tested physiologic indices at 8-15-th and 25-30-th days at birth have revealed the coincidence with some critical periods of early postnatal ontogenesis—immunodeficiency, depression of the stressogen reaction, depression of dominance and retardation. As a conclusion, the registered changes had a phasic character.

Conclusions

1. There were observed that the changes in the studied physiological indices (total proteins, protein particles, glucose, alkaline reserve, macro elements Ca, P, Na, K, cortisol, bactericide activity) while applying the combined temperature and noise stressing factors have a phasic character and have been influencing – by increasing or decreasing its values during early postnatal ontogenesis. The most evident changes have been noted at the 8-15-th days and 25-30 days at birth. These changes have corresponding with critical periods of ontogenesis: immunodeficiency, depression of the stressogen reaction, depression of dominance and retardation.
2. A tendency of increased bactericide activity and the level of cortisol in blood (with exception at the 15-th day) have been observed while applying the combined stressor factors, that proves the fact of some increased resistance level and adaptive capacity of the animal organisms.
3. There were observed that the impact of the combined abiotic and biotic factors (stressing temperature + excessive noise + parasitic agents) essential aggravates the metabolic processes in the organism of the calves as compared to these while applying mono factorial stressors.

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