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Features of the formation of lambs' adaptive capacity in the first day of life

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Abstract

New-born lambs are subjected to significant loads during rearing with the existing technologies of sheep farming. The stability and ability to adapt of newborn animals is not the same and is conditioned by different functional maturity, low resistance, and high susceptibility to extreme biotic and abiotic factors. Because of this, their physiological condition deteriorates, the body defenses decrease, which most often leads to a decrease in productivity, an increase in morbidity and mortality. Knowledge about the development of the clinical condition and thermoregulation in lambs during early ontogenesis is quite limited, which determines the relevance and expediency of the work conducted, the purpose of which was to investigate the peculiarities of the formation of adaptive capacity in newborn lambs during the first day of postnatal rearing. As part of the experiment, it has been determined that the body temperature of the lambs on the first day after birth varied with different intensity from the initial value. This was affected by the differences in the modules of its deviation, which made it possible to distinguish three groups with different levels of thermoregulation processes. Lambs of group I were the most viable, which were born with 5.1 and 9.9% more live weight at a higher metabolic rate of 1.0378 *vs.* 1.0331 and 1.0300 in lambs of groups II and III and reliably higher by 5.0 and 14.9% of pulse rate parameters and 4.7 and 27.7% of breathing rhythm, thereby ensuring sufficient functioning of thermoregulation mechanisms. It was found that the level and nature of the correlation between live weight and physiological indicators (live weight, pulse and breathing rates) indicate the multi-vector relationship in lambs with different body temperature deviation modules. These dependencies were especially clearly manifested in individuals of the group I (r=-0.522; r=0.362; r=0.707, respectively). It was recorded that the microclimate in the room for keeping ewes and newborn lambs in terms of hydrogen sulfide content almost twice exceeded the technological norm of industry-specific process engineering standard, while other zoohygienic parameters approached its upper limit.

Key words: *ewes; microclimate; deviation module; respiration and pulse rate; body temperature; lambs*

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Introduction

In most regions of Ukraine, the stabling period for sheep begins at the end of October and lasts until the end of April and the beginning of May. For the most part, lambing of ewes and suckling of lambs takes place during this period. Among the numerous problems of the available technologies of sheep farming in this period, the formation of healthy offspring, prevention of disease and preservation of livestock are extremely important. However, the difficulty of solving these problems from a technological point of view lies in the fact that the body of a newborn lamb in the first days of postnatal ontogenesis has an inherent reduced adaptive potential in relation to environmental conditions.

It is well known that the viability of newborn animals and the formation of their clinical status in the initial period of postnatal development act as marker indicators in the activation of thermoregulatory processes, the biological meaning and character of which is to maintain the relative constancy of the organism and release heat under the adverse effects of the environment (Aleksiev et al., 2007; Wallace et al., 2021). In this period, when the functional features of the newborn animal are not yet clearly manifested, the formation of thermoregulatory, cardiovascular, respiratory, metabolic and homeostatic mechanisms are completed, which requires an adaptation period (Piccione et al., 2007; Dwyer, 2008b). The rhythmicity of heat production by a newborn body, due to internal physiological factors, is the lowest in the morning hours and daylight hours, while its increased losses are most important for its survival at the end of the second half of the day and at night, when the ambient temperature drops (Habibu et al., 2022). Insufficient thermal stability of the sheep body at birth can lead to hypothermia and lethality (Mellor and Stafford, 2004; Todini, 2007; Mccoard et al., 2014; Plush et al., 2015). Despite the fact that their internal body temperature ranges from 38.5°C to 39.5°C (Piccione et al., 2002; Piccione et al., 2005).

Instead, it is known that the temperature equilibrium state of the dynamic environment in which the biological processes of the newborn animal organism take place is the most critical in the first five hours after lambing (Hernández-Castellano et al., 2015). During this period, the greatest heat losses occur, but the second period occurs from the 12th to the 36th hours of postnatal development, when the depletion of energy reserves suppresses heat production (Plush et al., 2015; Habibu et al., 2022). The breed and sex of newborns, in particular goat kids and lambs, are also influential factors that form the thermopotential of their body (Dwyer and Morgan, 2006; Todini, 2007). Environmental temperature, their temperament and physiological state also have a strong effect on this process (Habibu et al., 2016; Macías-Cruz et al., 2017). Their vision of the problem is stated in the works (Mccoard et al., 2014; Labeur et al., 2017; Vicente-Perez et al., 2019), emphasizing that unfavorable environmental conditions (long cold) cause a gradual decrease in rectal temperature in newborn lambs. This happens against the background of an ultra-fast and deep drop in temperature on the surface of the body. Rectal temperature is the primary variable responsible for synchronizing peripheral function (Brown et al., 2002), while heart rate and respiration are secondary in the physiological hierarchy. The temperature on the surface of the body is considered a key parameter that reflects the state of interaction of the organism with the environment (Menant et al., 2020).

In addition, the viability of the lamb before the first consumption of colostrum is interrelated with its live weight. Loss of live weight by an animal after birth may indicate a violation of its neonatal adaptation and resistance capabilities (Dwyer and Morgan, 2006; Palii et al., 2020).

A higher surface area to body mass ratio, as well as a lower amount of fat and muscle tissue under the skin, may indicate a high susceptibility of lambs with low live weight to release their body heat to the outside (Dwyer, 2008b; Mccoard et al., 2017). Live weight of lambs and body surface temperature are interrelated characteristics (Dwyer and Morgan, 2006; Vicente-Perez et al., 2019). On the other hand, the most common factor in the loss of young animals and hypothermia in the first days of postnatal life is insufficient communication between the ewe and the newborn (Poindron et al., 1984; Dwyer et al., 2001; Celi and Bush, 2010).

During this period of time, the maternal instinct is intensively manifested in most ewes – licking the lamb, stimulating it to stand up and to search for the udder, protection. In this way, the newborn is provided with the first protective immunity and the accumulation of energy necessary for thermoregulation in the future (Nowak and Poindron, 2006; Dwyer et al., 2016). At the same time, the analysis of available sources of literature shows the lack of a single point of view among scientists and the contradictions of the obtained results, which are aggravated by the limitation and fragmentation of data on young sheep and their changes in the time interval. These processes become especially acute with the development of global climate changes and the associated frequent recurrence of years with increased air temperature. The obtained information will make it possible to offer effective management programs for the rational reproduction of sheep in the functional system "mother-newborn lamb", as well as to introduce auxiliary biological tests for the selection of viable animals – as a significant indicator of increasing their productive and reproductive potential. That is why the work carried out acquires special relevance and practical value.

The purpose of the research was to investigate the peculiarities of the formation of adaptive capacity in newborn lambs during the first day of postnatal rearing.

Materials and methods

The scientific and economic experiment was carried out in the production conditions of the State Enterprise Research Farm "Hontarivka" of the Institute of Animal Science of the NAAS, Chuguyiv district of the Kharkiv region. For the experiment, a group of ewes of the Kharkiv inbred type of Prekos sheep was formed, which were in the same flock and were previously artificially inseminated in the autumn of 2021. They were represented by typical animals that, according to the assessment of the main indicators of wool productivity and quality, met the requirements of the elite class, were 4 years old, had a live weight of 63-65 kg and unwashed wool shearing – 4.7-4.9 kg. Three 4-year-old breeder rams were used for reproduction, with an average live weight of 115 kg, wool shearing – 10.4 kg, elite class. The research was carried out on the fodder background that was developed in the experimental farm: during the spring-summer period, the experimental ewes were grazed on natural pastures, supplemented with concentrated fodder, in the autumn-winter period, the ewes were kept by the sheepfold - basis method, they were fed with hay of cereal and leguminous crops, silage, concentrates, balancing feed additives. Two days before the expected date of lambing, experimental ewes were separated into a separate box to avoid disturbance. Lambing took place in the first decade of February, during which the obtained offspring were evaluated.

Maternal behavior of ewes was assessed (depending on sex and type of newborn lambs) by visual observation of the duration of lambing and timing of the total lamb licking time after birth (Dwyer, 2008a). Newborn lambs – by the length of time from birth to: the first attempt to stand up; by the number of attempts spent on steady standing; finding the udder and showing the reflex of consumption of the first portions of colostrum, as well as the total time of its consumption. The registration of the manifestation of ethological acts in ewes and newborn lambs was recorded by three observers in the record book at a distance of about 10 m, which is quite sufficient to not disturb the physiologically formed behavior of the animals.

The viability of newborn lambs was studied according to the indicator of the dynamic characteristics of the thermogenesis processes in their body and changes in live weight during the first day after birth, by individual weighing.

The level of viability of lambs was determined by calculating the metabolic rate according to formula:

$$Km = \frac{M_1}{M_2} \quad (1)$$

where:

K_m – is the metabolic rate;

M_1 – live weight of the lamb at birth, kg;

M_2 is the live weight of a lamb at the age of one day.

Physiologically mature lambs were considered, in which the metabolic rate was equal to or greater than one.

The level of perfection of thermoregulatory processes in newborn lambs was studied by the dynamic characteristics of body temperature changes immediately after lambing and its fluctuations in the interval after 1, 2, 4, 6, 12, 24 hours, since this period is considered the most critical. The parameters of thermogenesis in the newborn organism were evaluated by the average daily modules of body temperature deviations, specific growth and limits of fluctuations for 24 hours of the newborn. The increase in body temperature of each lamb was calculated as the ratio of the difference between the next and previous measurement to the initial value. And then the calculated values of body temperature deviations for each measurement period were added. The grouping of lambs according to the average module of body temperature deviation during the daily cycle of observations made it possible to distinguish three groups of animals. The first group included lambs in which this indicator was close to 0 and was in the range from +0.2°C to -0.2°C. The second group included lambs with higher indicators – from +0.3°C to +0.9°C, and the third group included animals whose body temperature deviation module was in the range from -0.3°C to -1.9°C. As a result, 25.0% of animals from the total sample were included in the first group, 30.0% in the second, and 45.0% in the third group. The breathing rate was recorded visually by chest movements and counting their number in one minute, the pulse rate by the number of heart contractions in one minute, the rectal temperature by a medical mercury thermometer, the temperature on the body surface by a non-contact Bosch laser thermometer.

The total duration of the studies was the first 24 hours after the birth of the lambs.

During manipulations with animals, the bioethical requirements of the Law of Ukraine "On the Protection of Animals from Cruelty Treatment" were observed (Information of the Verkhovna Rada of Ukraine No. 27, 2006, On the protection of animals from cruel origins). The research program is approved by the Bioethics Committee of the Institute of Animal Science of the National Academy of Agrarian Sciences of Ukraine.

At the same time, during the taking of the clinical parameters of the animals, the microclimate parameters were monitored in three zones of the room and at two points (at the level of the height of the service personnel – 1.7 m and the height of the animal's head – 0.6 m) from the upper layer of the straw bedding. The temperature and relative humidity of the air, the concentration of carbon dioxide and hydrogen sulfide in the room were measured using the "Dozor" device, the air velocity was measured with a vane anemometer. The relationship between the main indicators was determined by calculating the phenotypic correlation coefficients.

The digital material of the experimental studies was processed by biometric methods using the Microsoft Excel 2010 application package. The difference was considered reliable at $P<0.05$. Graphical interpretations of the results were assessed using visual programming in the Microsoft Excel 2010 environment.

Results and Discussion

The formation of the physiological status and thermostability of lambs at birth and within 24 hours after it is quite naturally determined by the behavior of their mothers. The results of its evaluation are shown in the Table. 1.

It was established that the behavioral reactions of the experimental samples were characterized by significant variability. Their variability depended, first of all, on how the ewes behaved with their lambs and after what time the offspring first began to consume colostrum. The lambing time of ewes varied from 5 to 9 minutes (7.3 minutes on average). However, in ewes lambing male lambs, this process was 19.7% longer than during the birth of female lambs. The reproductive activity of ewes that lambed singles and twins did not have significant differences over time. No stillborn lambs were recorded among the newborn offspring. In most of the studied ewes (65.0% of cases), immediately after the birth of the offspring, a high maternal instinct was manifested, and they began to intensively lick the lambs. In the rest of the ewes, it appeared

Table 1. Behavior of ewes and newborn lambs

Element of behavior	Sex and type of birth of lambs / time, minutes			
	male lambs	female lambs	singles	twins
Duration of lambing in ewes	7.3	6.1	6.5	6.2
The total time the ewe licks the lambs after birth	32.7	26.2	30.2	20.0
The time from birth to the first attempt of the lambs to stand up	11.3	11.9	12.5	8.5
The period from birth to the lamb's first consumption of the first portions of colostrum	41.2	35.9	38.7	32.5
Total time of colostrum consumption	20.8	19.6	20.4	18.5
The number of attempts of lambs to keep on their feet	7.1	12.1	10.3	12.0

somewhat delayed for 1-2 minutes. The total time spent on careful licking of lambs by ewes ranged from 12 to 42 minutes. This process was 24.8% longer in relation to newborn males compared to females. The difference in the time of licking by ewes of single lambs and twins was more significant and amounted to 51.0% in favor of single lambs.

The first attempts to stand up and consume colostrum after birth in twins occurred on average 4.0 and 6.2 min earlier compared to singles. Within the distribution by gender, the female ones turned out to be more active in the implementation of these acts of behavior than the male lambs, respectively, by an average of 0.6 and 5.3 minutes. The total duration of the colostrum consumption phase ranged from 11 to 28 min, however, male lambs spent 1.2 min or 6.1% more time on this process, while the twin offspring showed its reduction – by 1.9 min or 9.3%. The number of attempts spent by the lambs for the stable standing on the legs was in the range from 5 to 15. On the other hand, male lambs were almost 1.7 times inferior to female ones on this indicator, and twins spent an average of 1.7 more attempts or 16.5% more on this act of behavior than singles. The obtained data indicate that male and female lambs born among singles were more physiologically mature and able to move faster independently after the ewe. This probably contributed to the fact that in the future they spent a longer time consuming colostrum.

Since the dynamics of changes in body temperature of lambs in the first hours of postnatal development is a key criterion for the normal reaction of their body to adverse environmental conditions, the influence of this factor was investigated.

The dynamics of changes in body temperature of lambs immediately after lambing and in the interval after 1, 2, 4, 6, 12, 24 hours are presented in the Table. 2.

Table 2. Body temperature changes in newborn lambs (*n*=20)

Lamb No.	Body temperature (°C) and time after birth (hours)								Deviation module
	at birth	1	2	4	6	12	24	average	
1	40.1	39.6	40.4	40.1	39.4	39.2	40.3	39.87	+0.20
	deviation*	-0.5	+0.8	-0.3	-0.7	-0.2	+1.1		
2	39.7	38.3	38.8	38.5	39.4	39.6	39.4	39.10	-0.30
	deviation	-1.4	+0.5	-0.3	+0.9	+0.2	-0.2		
3	39.1	39.0	39.2	39.8	39.7	39.0	39.6	39.34	+0.50
	deviation	-0.1	+0.2	+0.6	-0.1	-0.7	+0.6		
4	39.2	40.7	39.1	38.8	39.2	39.8	39.6	39.49	+0.40
	deviation	+1.5	-1.6	-0.3	+0.4	+0.6	-0.2		
5	39.7	39.6	38.9	39.2	39.6	39.4	38.8	39.31	+0.10
	deviation	-0.1	+0.3	+0.3	+0.4	-0.2	-0.6		
6	39.3	39.8	38.8	39.8	39.1	39.7	39.6	39.44	+0.30
	deviation	+0.5	-1.0	+1.0	-0.7	+0.6	-0.1		
7	39.5	39.3	39.1	38.8	39.3	38.9	39.1	39.14	-0.40
	deviation	-0.2	-0.2	-0.3	+0.5	-0.4	+0.2		
8	40.2	40.4	39.6	39.2	38.8	39.1	39.9	39.60	-0.30
	deviation	+0.2	-0.8	-0.4	-0.4	+0.3	+0.8		

9	39.8	38.2	38.0	37.4	38.6	39.3	39.7	38.71	+0.90
	deviation	-0.6	-0.2	-0.6	+1.2	+0.7	+0.4		
10	38.6	37.3	37.1	38.4	38.8	39.9	39.2	38.47	+0.60
	deviation	-1.3	-0.2	+1.3	+0.4	+1.1	-0.7		
11	39.1	38.1	38.6	39.7	40.1	39.3	39.8	39.24	+0.70
	deviation	-1.0	+0.5	+1.1	+0.4	-0.8	+0.5		
12	40.0	39.3	39.1	38.4	38.7	39.1	39.6	39.17	-0.40
	deviation	-0.7	-0.2	-0.7	+0.3	+0.4	+0.5		
13	40.2	39.8	38.8	39.2	39.3	38.6	39.5	39.34	-0.70
	deviation	-0.4	-1.0	+0.4	+0.1	-0.7	+0.9		
14	39.0	39.4	39.4	39.1	39.8	38.7	39.2	39.23	+0.20
	deviation	+0.4	0	-0.3	+0.7	-1.1	+0.5		
15	40.1	39.8	39.5	38.2	38.8	39.2	39.9	39.36	-0.20
	deviation	-0.3	-0.3	-1.3	+0.6	+0.4	+0.7		
16	40.5	39.9	39.4	38.7	38.2	39.4	39.5	39.37	0
	deviation	-0.6	-0.5	-0.7	+0.5	+1.2	+0.1		
17	40.0	38.2	39.1	39.4	38.8	37.1	38.1	38.67	-1.90
	deviation	-1.8	+0.9	+0.3	-0.6	-1.7	+1.0		
18	39.7	39.4	39.2	38.1	38.4	39.5	39.7	39.14	-0.60
	deviation	-0.3	-0.2	-1.1	-0.3	+1.1	+0.2		
19	39.5	39.0	39.4	38.8	39.4	39.2	39.0	39.19	-0.50
	deviation	-0.5	+0.4	-0.6	+0.6	-0.2	-0.2		
20	39.4	39.0	39.1	39.4	38.4	39.0	38.2	38.93	-1.20
	deviation	-0.4	+0.1	+0.3	-1.0	+0.6	-0.8		
The sample average									
n=20	39.64 ±0.11	39.21 ±0.19	39.03 ±0.15	38.95 ±0.15	39.09 ±0.12	39.15 ±0.13	39.38 ±0.12	39.21	+0.20
	deviation	-0.4	+0.2	0	+0.1	+0.1	+0.2		

Note: * deviation between adjacent time intervals.

It was established that changes in body temperature of lambs during the first day of postnatal life had various directions, which is an indicator of the individual response of the body to the influence of environmental temperature. In particular, the average value of the body temperature for the group of examined newborn lambs was 39.21°C with fluctuations from 38.95°C to 39.64°C.

However, studying the dynamics of changes in body temperature in lambs, it can be stated that the sharpest decrease occurred in the first hour after their birth and continued for the next four hours (Fig. 1).

In general, during this period the body temperature of the lambs decreased by 0.69°C. And although in the following hours, its gradual growth was noted, nevertheless, at the end of the first day of life, this indicator remained lower than that of lambs immediately after birth.

When determining the nature and magnitude of the relationship between

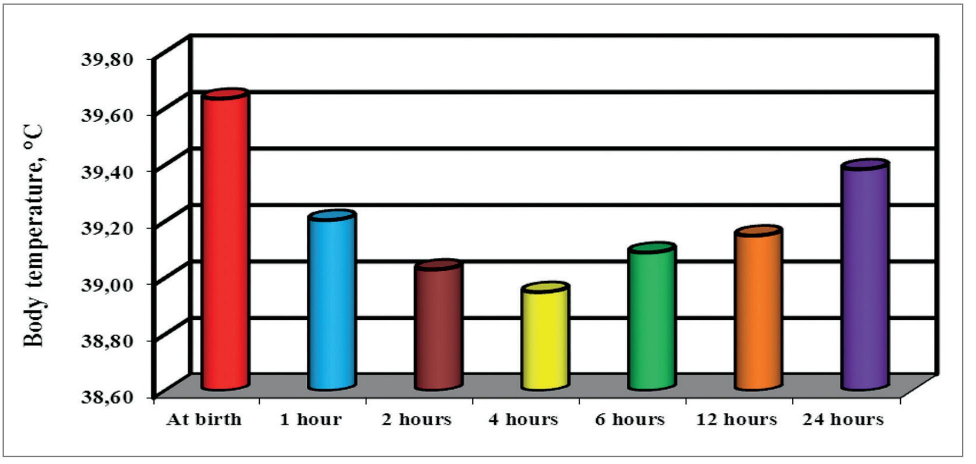

Figure 1. Fluctuations in body temperature of lambs during the first day of their life (average of the sample).

changes in thermogenesis parameters in lambs from birth to the 24th hour of their life, a positive and moderate correlation was found in male lambs, where r = 0.511, against r = 0.036 in female lambs.

A positive, but weaker correlation coefficient between these indicators was also observed in lambs born as singles (r = 0.383). Despite this, the value of the corresponding dependence in twins, on the contrary, was weak and negative – r = -0.169.

The grouping of lambs according to the average module of body temperature deviation during the daily cycle of observations made it possible to distinguish three groups of animals. The first group included lambs in which this indicator was close to 0 and was in the range from +0.2°C to -0.2°C. The second group included lambs with higher indicators – from +0.3°C to +0.9°C, and the third group included animals whose body temperature deviation module was in the range from -0.3°C to -1.9°C. As a result, 25.0% of animals from the total sample were included in the first group, 30.0% in the second, and 45.0% in the third group.

A comparison of body temperature indicators of lambs at birth revealed a reliable advantage of animals from groups I and III by 0.7°C (P<0.01) and 0.6°C (P<0.05) over peers from group II. Whereas at the end of the first day, the body temperature of the lambs from the compared groups stabilized and had no significant differences between them (Table 3).

Table 3. Average body temperature of lambs with different deviation module per day, (X±Sx)

Group	Average body temperature by periods, °C		
	at birth	for the 24th hour	average for the day
I (*n*=5)	39.88±0.25^{0}	39.54±0.26	39.43±0.11
II (*n*=6)	39.18±0.16	39.58±0.08	39.12±0.17
III (*n*=9)	39.80±0.10^{00}	39.17±0.21	39.14±0.09

Note: $^{0}P<0.05$; $^{00}P<0.01$ – reliability of difference to the group II.

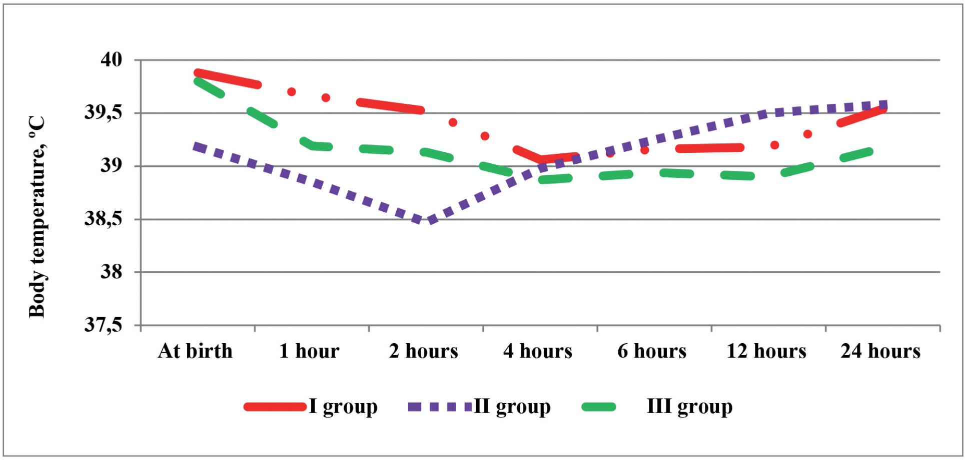

Figure 2. Dynamics of body temperature of lambs with different modules of its deviations in the daily cycle of observations.

The difference in the process of thermoadaptation of the lambs in the compared groups can be traced more clearly in Fig. 2.

The body temperature of lambs of the II group changed most dynamically during the observation cycle. Although it was the lowest at birth, during the first two hours of the lambs; life it decreased very rapidly (almost by 1°C), and in the following hours it began to rise similarly rapidly. Due to this, at the end of the observations, they were on par with peers of the first group in terms of this indicator.

The lambs of the first and third groups were characterized by a slow rate of body temperature reduction up to the 4th hour of life, and then they had significant differences. The first group was characterized by gradual growth, and the third was characterized by relative stabilization at a relatively low level compared to peers of other groups. In general, the first 2 – 4 hours of their life were the most critical in the process of thermoregulation of newborn lambs.

Experiments have established that lambs with different modules of body temperature deviation had practically the same values of live weight both at birth and after 24 hours of observation. However, the young animals of the group I at birth slightly exceeded the peers of the groups II and III by 0.23 and 0.43 kg (5.1 and 9.9%), respectively, by this indicator, but for the 24th hour of their life, the difference compared to the peers of the group III gained of statistical significance (P<0.05)

Table 4. Live weight of lambs with different modules of deviation of body temperature, (X±Sx)

Group	Live weight, kg		
	at birth	after 24 hours	Metabolism coefficient
I (*n*=5)	4.76±0.16	4.94±0.17*	1.0378
II (*n*=6)	4.53±0.19	4.68±0.19	1.0331
III (*n*=9)	4.33±0.14	4.46±0.14	1.0300

Note: *P<0.05 – reliability of difference to the III group. Source: Authors' own results.

with a higher metabolic rate – 1.0378 versus 1.0331 and 1.0300, respectively, in lambs of the groups II and III (Table 4).

No deviations from the physiological norm were observed in the number of respiratory movements and heart rate per minute in the lambs. In particular, the rhythmicity of breathing averaged, respectively, 38.67-49.40 respiratory movements of the chest per minute with good filling of the arterial pulse – 65.78-75.60 pulse beats per minute, with a highly reliable difference between these indicators ($P<0.01$ – $P<0.001$ in both cases of comparison) in lambs of groups I and II compared to peers of group III, which indicated their higher viability (Table 5).

The results of determining the correlation coefficients indicate that a weak negative relationship, and in the case of the group II a positive relationship (r = -0.227-0.222) was established between the live weight and body temperature of newborn lambs with different modules of deviation. Between live weight and heart rate, the nature of the relationship was positive, but its magnitude turned out to be multi-vector: in lambs of groups I and II it was average r = 0.362 and r = 0.583, respectively, while in the young animals of group III the level of the corresponding combination between these indicators slightly deepened and was the highest – r = 0.890 (Table 6).

The relationship between live weight and respiration rate also had different strength and character. In particular, the correlation coefficient between these indicators in lambs from group III was quite low and negative (r = -0.301), in the group II of young animals, this dependence was even weaker, negative and almost absent – r = -0.091. In turn, the closest, strong and positive relationship between these indicators was observed in animals of the group I – r = 0.707. It should be noted that the values of live weight in newborn lambs and the frequency of their pulse and breathing

Table 5. Main indicators of the physiological status of newborn lambs with different modules of body temperature deviation, (X±Sx)

Group	Parameters of the physiological status of newborn lambs		
	body temperature, °C	pulse rate, beats per minute	frequency of breathing, movements per minute
I (*n*=5)	39.88±0.250	75.60±1.21***	49.40±1.86***/^{00}
II (*n*=6)	39.18±0.16	72.00±1.48**	47.17±0.83**
III (*n*=9)	39.80±0.1000	65.78±1.41	38.67±1.30

Note: $^{**}P<0.01$; $^{***}P<0.001$ – reliability of difference to the group III; $^{0}P<0.05$; $^{00}P<0.01$ – reliability of difference to the group II.

Table 6. Relationship between live weight and parameters of the physiological state of newborn lambs with different modules of body temperature deviation

Indicator	Group		
	I (*n*=5)	II (*n*=6)	III (*n*=9)
Live weight – body temperature	-0.522	0.222	-0.227
Live weight – pulse rate	0.362	0.583	0.890
Live weight – respiratory rate	0.707	-0.091	-0.301

Table 7. Body surface temperature and its relationship in ewes and newborn lambs, (X±Sx)

Indicator	Sex		On the average by group
	female lambs	male lambs	
Number of animals, heads	14	6	20
Temperature on the body surface of ewes, °C	15.31±0.43	15.77±0.23	15.54±0.31
Live weight of lambs, kg	4.38±0.09	4.68±0.20	4.53±0.08
Temperature on the surface of the body of lambs, °C	27.05±0.44	28.30±0.92	27.68±0.42
The temperature on the body surface of the ewes – the live weight of the lambs	-0.149	0.610	-0.019
The temperature on the body surface of the ewes – temperature on the body surface of lambs	0.152	0.673	0.240

were better combined in animals of this group.

Based on the reasoning that the body temperature on the surface of the body of ewes is also one of the fairly objective criteria for assessing the viability of their offspring in the first periods of life, the next step was to determine the correlations between the body temperature in the back sites of ewes and the offspring obtained from them, and also between the body temperature of ewes and the live weight of newborn lambs (Table 7).

Different levels and the presence of correlation between these parameters were established depending on the sex of the young animals. In particular, the closest positive and medium interdependence between these indicators was observed in male lambs with correlation coefficients r = 0.610 and 0.673, respectively, in contrast, the correlation between body temperature and live weight of female lambs, had the opposite sign, -0.149 and it was weak. The body temperature of ewes and newborn lambs was also weakly but positively correlated (r = 0.152). The lack of correlation between the values of live weight and body temperature in females versus male lambs may indicate a higher susceptibility of their body to the influence of temperature and humidity factors on the one hand, and on the other – due to their physiological features.

As additional criteria for assessing the adaptive capacity of newborn lambs and their mothers, the parameters of the microclimate, which were directly formed under the influence of external environmental conditions, were determined. It should be noted that the air temperature in the sheepfold decreased with a decrease in the temperature index of the outside air, and, on the contrary, as it rises, the temperature in the sheepfold increased and had both a daily and a spatial character. The optimal air temperature regime for both the height of the staff and the height of the animal was noted in the right part of the room, the values of which varied during the research from +11.1 to 15.6°C and from +10.9 to 14.8°C, compared to the central part of the building (+10.8 – 13.2°C and +10.3-12.9°C), and, especially, with the left part (+6.3-12.5°C and +5.9-12.3°C). The peak air temperature was registered at 12 PM. The uneven distribution of air temperature from 1 AM to 12 PM was: in the right part of the room 4.5 and 3.9°C, in its central part – 2.4 and 2.6°C, and in the left part – 6.2 and 6.4°C. In the subsequent period of the daylight, the air temperature decreased. The parameters of relative air humidity also had different values in separate parts of the room and approached the upper limit of the technological norm, which is caused by the inefficient operation of the ventilation system. At the same time, the level of water vapor content in the air was 77-63% at the height of the staff and 76-59% at the height of the animal in the right part, 89-69 and 88-64% in the center and 83-65 and 82-62% – the left part of the room. A slight decrease in temperature and increase in air humidity in the room at 9 AM was due to the opening of the end gate for the feed dispenser to enter and the inflow of cold air from outside. The air velocity indicators in different parts of the room varied from 0.11 m/s to 0.16 m/s. The course of daily fluctuations of the microclimate in the sheepfold had a clear pattern of accumulation of carbon dioxide content in the air, starting from 1 AM, which reached its maximum value at 9 AM both in different places where the animals were placed and in the measurement points. Unfavorable zoohygienic conditions in this time period of the day were formed under the influence of daily technological processes of feed distribution, which caused an increase in the motor activity of animals, intensification of defecation and urination, and led to an increase in the concentration of CO_2 in the air reaching a maximum. After 9 AM, the technological processes of animal life support in the facility ended and their motor activity decreased somewhat, which led to a gradual decrease in the CO_2 concentration at 3 PM from 0.217% (at the height of the service personnel) and 0.194% (at the level of the resting place of the animals), respectively, to 0.104 and 0.101% in the right part (placement of the "gross"), from 0.235 and 0.203% to 0.121 and 0.107% in the center and from 0.258 and 0.216% to 0.169 and 0.1.58% in the left part (place for keeping ewes with lambs). However, these values did not exceed the technological norm, approaching its upper limit. While the concentration of hydrogen sulfide in the air of sheep farms, regardless of the area where the animals are located and the place where the measurements were taken, turned out to be quite uniform (2.0-2.6 mg/m^3), but this is almost 2 times higher than the technological norm and is caused primarily by the complete closure of ventilation shafts and wall inlet channels.

In the course of clinical studies of the state of the ewes' bodies significant daily fluctuations in their body temperature, pulse rate and number of respiratory movements were not registered: all of them corresponded to the physiological norm. In particular, the body temperature from 1 AM to 3 PM ranged from 38.9 to 39.4°C, pulse rate – from 69.3 to 77.6 beats per minute, respiratory rate – from 45.1 to 58.6 respiratory movements per minute.

Conclusions

It has been determined that the body temperature of the lambs on the first day after birth changed with different intensity from the initial value. This was affected by the differences in the modules of its deviation, which made it possible to distinguish three groups with different levels of thermoregulation processes. Lambs of group III were the most viable. They were born with 5.1 and 9.9% more live weight with a higher metabolic rate of 1.0378 versus 1.0331 and 1.0300 in lambs of groups II and III and reliably higher by 5.0 and 14.9% pulse rate parameters, and 4.7 and

27.7% higher breathing rhythm, thereby ensuring sufficient functioning of thermoregulation mechanisms.

It was found that the level and nature of the correlation between live weight and physiological indicators (live weight, pulse and breathing rates) indicate the multi-vector relationship in lambs with different body temperature deviation modules. These dependencies were especially clearly manifested in individuals of the group I (r = -0.522; r = 0.362; r = 0.707, respectively). It was recorded that the microclimate in the facility for keeping deeply-pregnant ewes and newborn lambs in terms of hydrogen sulfide content almost twice exceeded the technological norm, while other zoohygienic parameters approached its upper limit. The most comfortable microclimate during the lambing period of the ewes is the right part of the facility, where the "gross" (deeply-pregnant ewes that will lamb first) were located, since the rest of its area is more densely populated with ewes that have already lambed and their offspring.

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Svojstva stvaranja sposobnosti prilagodbe janjadi prvog dana života

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Tijekom uzgoja s postojećim tehnologijama uzgoja ovaca novorođena janjad podložna je znatnim opterećenjima. Stabilnost i sposobnost prilagodbe novorođenih životinja nije ista i uvjetovana je različitom funkcionalnom zrelošću, niskom otpornošću i visokom prijemčivošću na ekstremne biotičke i abiotičke čimbenike, iz tog razloga se njihovo fiziološko stanje pogoršava, smanjuje se obrambeni mehanizam organizma, a to najčešće dovodi do smanjene produktivnosti, povećanja morbiditeta i smrtnosti. Znanje o razvoju kliničkog stanja i termoregulaciji u janjadi tijekom rane ontogeneze prilično je ograničeno, a to određuje relevantnost i hitnost obavljenog rada čija je svrha istražiti posebnosti stvaranja sposobnosti prilagodbe u novorođene janjadi tijekom prvog dana uzgoja nakon janjenja. Kao dio eksperimenta, utvrđeno je da je tjelesna temperatura janjadi prvog dana nakon janjenja u odnosu na početnu vrijednost varirala različitim intenzitetom. Na to su utjecale razlike u modulima odstupanja koje su omogućile razlikovanje tri skupine s različitim razinama procesa termoregulacije. Janjad iz skupine I bila je najodrživija, a ojanjena je s 5,1 i 9,9 % više žive vage uz veću metaboličku stopu od 1,0378 u usporedbi s 1,0331 i 1,0300 u janjadi iz skupine II i III te s pouzdano višim parametrima srčane frekvencije za 5,0 i 14,9 % i stope disanja 4,7 i 27,7 %, čime je osigurano dostatno funkcioniranje mehanizama termoregulacije. Otkriveno je da razina i narav korelacije između žive vage i fizioloških indikatora (živa vaga, srčana frekvencija i stopa disanja) ukazuju na multi-vektorski odnos u janjadi s različitim modulima odstupanja tjelesne temperature. Ove su se ovisnosti posebno jasno očitovale u janjadi iz skupine I (r = -0,522; r = 0,362; odnosno r = 0,707). Zabilježeno je da je mikroklima u prostoriji za držanje ovaca i novorođene janjadi, u smislu udjela sumporovodika, bila gotovo dva put veća od tehnološke norme standarda procesnog inženjeringa specifičnog za industriju, dok su drugi zoo-higijenski parametri bili blizu gornje granice.

Ključne riječi: *ovce, mikroklima, modul odstupanja, stopa disanja i srčana frekvencija, tjelesna temperatura, janjad*