

Original research

Productivity and metabolic features of ewes of the
pridneprovskaya meat breed during the suckling period

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Abstract. Results of study of complex metabolic indicators in ewes of the Dnieper meat breed at the initial stage of the suckling period are presented. The aim of the study was to determine the productive, biochemical and hematological indicators in ewes and lambs depending on the number and sex of newborn lambs. The animals were divided into two groups ($n = 5$). The first group included ewes that gave birth to one lamb, the second group consisted of ewes with twin lambs. The results of the study showed that during the first 20 days of the suckling period the milk yield of ewes, which fed one lamb, was at the level of 26.5 kg for ewe-lambs and 27.5 kg for ram-lambs, while with twins the total milk yield was 43.5 kg. As a result, the average daily milk yield during this period for ewes with single lambs was 1.33–1.38 kg, and for ewes with twins 2.18 kg, which was 58.0–63.9% more. The growth rate was higher in single lambs compared to twin lambs, among ram-lambs it was 34.5%, and among ewe-lambs – 27.1% ($p < 0.01$). Determination of the chemical composition of milk of the experimental groups of ewes showed that the protein content corresponded to the basic values – 5.84% and 5.82%. As well as the lactose content was at the level of 4.77 and 4.78%. In the milk of ewes with single lambs, the fat content was 5.56%, which was slightly higher in relation to ewes with twins by 0.14%. The results of the morphological analysis of blood showed a higher number of erythrocytes – 9.1 ± 0.27 T/l in ewes with twins compared to that in ewes with one lamb – 8.7 ± 0.17 T/l. A higher hemoglobin content was also determined in ewes with twins. However, the number of leukocytes in this group was 23.5% lower comparing to ewes with single lambs, which may be associated with a greater metabolic load on ewes with twins. The observed growth retardation of lambs born as twins compared to singletons may also be a consequence of metabolic depletion. The results obtained indicate metabolic stress during the suckling period and are important for their application in breeding and prediction of livestock productivity.

Keywords: lambs; growth rate; milk yield; milk composition; blood biochemistry.

Продуктивність і метаболічні особливості вівцематок придніпровської м'ясної
породи під час підсисного періоду

Анотація. Представлено результати вивчення комплексних показників метаболізму у вівцематок придніпровської м'ясної породи на початковій стадії підсисного періоду. Метою дослідження було визначення та аналіз відмінностей продуктивних, біохімічних та гематологічних показників у вівцематок та ягнят в залежності від кількості і статі новонароджених ягнят. Згідно мети дослідження тварини були поділені на дві групи ($n = 5$). До першої групи були включені матки які родили одне ягня, друга група складалася з маток з ягнятами-двійнями. Результати дослідження показали, що молочність вівцематок за перші 20 днів підсисного періоду, які відгодували одне ягня була на рівні 26,5 кг за ярочками і 27,5 кг – баранцями, тоді як з двійнятами сукупна молочність склала 43,5 кг. В результаті середньодобова молочність у цей період маток з ягнятами-одинаками склала 1,33–1,38 кг, а у маток з двійнями 2,18 кг, що було більше на 58,0–63,9%. Інтенсивність росту була вищою у ягнят-одинаків порівняно з ягнятами-двійнями, між баранцями вона становила 34,5%, а ярочками – 27,1% ($p < 0,01$). Визначення хімічного складу молока дослідних груп маток показало, що вміст білка відповідав базовим значенням – 5,84% та 5,82%. Так само, як і вміст лактози був на рівні 4,77 та 4,78%. У молоці вівцематок з ягнятами-одинаками вміст жиру становив 5,56%, що було незначно вищим стосовно вівцематок з двійнями на 0,14%. Результати морфологічного аналізу крові показали вищу кількість еритроцитів – $9,1 \pm 0,27$ Т/л у вівцематок з двійнями у порівнянні з такою у маток з одним ягням – $8,7 \pm 0,17$ Т/л. Більший вміст гемоглобіну, також, був визначений у вівцематок з двійнями. Однак, кількість лейкоцитів в цій групі була на 23,5% нижчою відносно маток з одинаками, що може бути пов'язано з більшим метаболічним навантаженням на вівцематок з двійнями. Виявлена затримка росту ягнят народжених двійнями у порівнянні з одинаками, також, може бути наслідком виснаження метаболічних процесів. Отримані результати вказують на метаболічний стрес впродовж підсисного періоду і мають важливе значення для їх застосування у селекції та прогнозуванні продуктивності тваринництва.

Ключові слова: ягнята; інтенсивність росту; молочність; склад молока; біохімічні показники крові.

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Introduction

Modern livestock farming imposes increasingly stringent requirements to the assessment of animal productivity, therefore, the urgent task is to increase the indicators of meat productivity and reproductive qualities of sheep using reliable breeding methods. This requires rational use of available resources, constant monitoring of productive and biological characteristics of sheep of newly created meat genotypes, which allows identifying the most promising animals for use (Polska, 2020; Zharuk, 2022).

The defining breeding traits of successful sheep breeding are increased fertility and milk production of ewes. It is the milk production of ewes that ensures the growth and development of newborn lambs in the first month of the neonatal period and subsequently contributes to the realization of the genetic potential of hereditary precocity (Lesyk & Pokhyvka, 2020). It should be taken into account that deficiencies in feeding and improper care of ewes during pregnancy significantly affect the overall development of the fetus – the duration of prenatal development, its weight and viability (Rooke et al., 2008; Cukharlov, 2010).

As in perfectly estimated sheep farming, ewes should deliver live lambs without complications, provide a reliable source of colostrum and milk, and create a stable maternal environment (Everett-Hincks et al., 2004; Dwyer, 2007). Litter size at lambing has a significant impact on the genetic assessment of the ability of ewes to further lambs feeding (Bunter et al., 2017). Moreover, lambs must adapt quickly to life outside the womb, as they need to start sucking milk shortly after birth to maintain adequate energy levels and body temperature (Everett-Hincks et al., 2014; Bunter et al., 2023).

Milk productivity of ewes for the proper level of feeding is dependent on the number of lambs born, the period of productive use, live weight and the level of provision of the necessary amount of nutrients in the feeding ration (Asín et al., 2021; Yakovchuk et al., 2021). Stapay and coauthors (2016) reported that the milk yield of ewes is very closely related to fertility, so for 100 days of lactation, the milk yield of ewes with one lamb was 97.2 kg, with two – 120.0 kg, with three – 153.0 kg, and with four – 169.1 kg. The chemical composition of sheep milk according to the main indicators is as follows – total dry matter content 17.8%, fat 7.4%, protein 5.7%, lactose 4.8% and ash 0.9% (Rooke et al., 2008; Stapay, 2010; Thomas & Haenlein, 2017).

The main metabolism in the ewes during all periods of development depends on the intake of nutrients and biologically active substances (Mykytiuk & Porotikova, 2020; Yefremov et al., 2020; Asín et al., 2021). The most convenient object for studying the condition of productive animals' key indicators of physiological and biochemical processes is a blood. In addition, hematological and biochemical blood parameters allow to assess dynamic changes of metabolism, the state of health of animals and, within certain limits, the nature of productivity (Vovkotrub et al., 2021).

The aim of the study was to define the differences in productivity and metabolism in ewes depending on both the number and gender of newborn lambs in early growing period.

Materials and methods

The experimental procedures of the research and the collection of the necessary results was carried out during lambing of ewes of the Dnieper meat breed at the sheep complex of the State Enterprise "Experimental Farm "Runo" of the Dnipropetrovsk region, as well as at the Department of Animal Feeding and Breeding Technology of the Dnipro State Agrarian and Economic University.

Two experimental groups of animals were formed with 5 animals each during lambing of ewes. The first group consisted of ewes that had delivered a single lamb, and the second group included ewes with twin lambs. The study used zootechnical methods for assessing productivity, in particular, determining the live weight of lambs at birth and at 20 days of age, average daily and total body weight gains using appropriate calculations (Ibatullin & Zhukorsky, 2017).

The milk yield of ewes was determined by multiplying the total growth of lambs from the day of birth to 20 days of life using a coefficient of 5, which assumes that the consumption of milk for the formation of 1 kg of lamb growth at this age is an average of 5 kg of milk.

To determine hematological and biochemical parameters, blood samples were collected from the ewes of both groups on the third day after lambing. Milk samples were collected from the ewes at the same stage to determine the chemical composition.

The total number of erythrocytes and leukocytes, hemoglobin concentration, and hematocrit value were determined in the blood by microcentrifugation using appropriate methods (Levchenko et al., 2020). Erythrocyte indices were mathematically calculated including color index (CI), hemoglobin content in erythrocytes (HbC) and mean erythrocyte volume (MV). Biochemical blood parameters were determined with automatic biochemical analyzer BioSystems BA 400 (Spain) using commercial reagent kits.

Chemical content of milk samples was measured using an ultrasonic milk analyzer Ekomilk Total (Ultrasonic Milk Analyzer) (BULTEH2000 Ltd., Bulgaria).

Statistical analysis of obtained results was carried out with specialized soft Statistica 10 application (StatSoft Inc., USA). Statistically significant level of the differences were accepted equal $P < 0.05$.

Results

In general, the condition and live weight of newborn lambs, both singletons and twins, met the standard, but were close to a minimum level. Different-sex lambs born alone did not differ significantly in live weight, which averaged 3.8 ± 0.14 kg in rams and 3.6 ± 0.09 kg in ewes. In twins, there were no differences in live weight at birth between rams and ewes, which was equal 2.6 kg (Table 1).

Significant differences in live weight indicators were found depending on the number of lambs born. In single lambs, the growth intensity was, as expected, higher compared to twin lambs, among ram-lambs it was 34.5 %, and among ewe-lambs – 27.1%

Table 1 – Growth rate of newborn young animals and milk yield of ewes (M ± m)

Gender	Live weight, kg		Live weight gain		Average milk yield of ewes, kg (per lamb)
	newborns	20 days	20 days, kg	daily, g	
Singletons					
Ram-lambs	3.8 ± 0.14	9.3 ± 0.13	5.5 ± 0.11	275.7 ± 1.29	1.38 ± 0.12
Ewe-lambs	3.6 ± 0.09	8.9 ± 0.10	5.3 ± 0.12	265.9 ± 1.34	1.33 ± 0.16
Twins					
Ram-lambs	2.6 ± 0.09	6.9 ± 0.10	4.3 ± 0.10	215.2 ± 1.28	1.09 ± 0.14
Ewe-lambs	2.6 ± 0.11	7.0 ± 0.10	4.4 ± 0.13	220.1 ± 1.19	1.10 ± 0.12

higher with significant differences ($p < 0.01$). Differences between both single lambs and twins depending on gender did not have significant differences. In lambs born alone, the advantage of 4,5% was on the side of ram-lambs, while among the twins, advantage was on a side of ewe-lambs – 1.5%.

Determination of the average daily gain in experimental lambs also confirmed the superiority of ram-lambs born as singletons in growth intensity, which for this period amounted to 275.7 ± 1.29 g. The average daily gain was somewhat lower in ewe-lambs – 265.9 ± 1.34 g, and in twins, respectively – 215.2 ± 1.28 and 220.1 ± 1.19 g.

The milk yield of ewes during the first 20 days of the suckling period was calculated. Thus, in ewes that gave birth to one lamb it was at the level of 26.5 kg for ewe-lambs and 27.5 kg for ram-lambs, while with twins the average milk yield was 43.5 kg. As a result, the average daily milk yield during this period in ewes with single lambs was 1.33-1.38 kg, and in ewes with twins it was 58.0–63.9% higher – 2.18 kg.

The study of the main indicators of the chemical composition of milk made it possible to establish that the protein content in the milk of ewes of both studied groups corresponded to the basic value and was 5.84 and 5.82% (Table 2).

In the milk of ewes with single lambs, the fat content was 5.56% and was slightly higher than in ewes with twins by 0.14 percent. The content of dry matter in milk is related to its chemical composition and in our case its amount was slightly higher in ewes with single lambs – 17.12%, while in ewes with twins – 16.94%, a similar ratio was for dry non-fat milk (DNFM) residue. As a result, the milk of ewes with single lambs had a higher caloric content – 952.5 kcal/

kg, while with twin lambs it was 938.4 kcal/kg. When determining the differences in the chemical composition of milk between the experimental groups of ewes, there was no significant difference ($p < 0.5$).

Statistically significant differences between groups of ewes were found in platelet content, other indicators were not statistically different (Table 3).

More significant differences were observed in the level of erythrocytogenesis in ewes with twins. They had not only a larger number of erythrocytes, but also a higher concentration of hemoglobin in them. In particular, the blood of these ewes contained a larger number of erythrocytes – 9.1 ± 0.27 T/l, while in ewes with one lamb there were fewer of them (8.7 ± 0.17 T/l). However, no significant difference in the number of erythrocytes was found between the experimental groups ($p < 0.5$).

The indicator of average mass of hemoglobin in erythrocytes (MSH) in both groups of animals did not differ significantly. In ewes with singles average hemoglobin mass in erythrocytes was 13.6 ± 0.24 pg, while in ewes with twins it was 3.8% ($p < 0.5$) lower.

It was found that the blood of ewes with twins contained a lower amount of leukocytes relative to ewes with singletons by 23.5%. The main mass of leukocytes is represented by segmented neutrophils. Thus, in ewes that gave birth to one lamb, their content was 57.0%, and in ewes that gave birth to twins, it was 52.5%. The level of lymphocytes in both groups of ewes was 41.5–45.0%. Prote, no significant differences between groups have been established.

The results of biochemical blood analysis reflect differences between experimental groups (Table 4).

Table 2 – Chemical composition of milk of ewes of the Dnieper meat breed, % ($M \pm m$)

Indices	Ewes with singles	Ewes with twins
Dry matter	17.12 ± 0.43	16.94 ± 0.51
Fat	5.56 ± 0.24	5.42 ± 0.18
Protein	5.84 ± 0.19	5.82 ± 0.23
Lactose	4.78 ± 0.21	4.77 ± 0.20
DNFM	11.56 ± 0.37	11.52 ± 0.45
Ash	0.94 ± 0.26	0.93 ± 0.31
Calorie content, kcal/kg	952.5	938.4

Table 3 – Hematological indicators of ewes' blood, ($M \pm m$)

Indicators	Ewes with singles	Ewes with twins
Hemoglobin, g/l.	119.1 ± 2.17	121.9 ± 1.97
Hematocrit, %	34.7 ± 0.91	36.3 ± 0.72
Erythrocytes, T/l.	8.7 ± 0.17	9.1 ± 0.27
Average erythrocyte volume, fl.	39.6 ± 0.68	39.9 ± 0.53
Average hemoglobin mass in erythrocyte, pg.	13.6 ± 0.24	13.1 ± 0.19
CI (color indicator), units	0.93 ± 0.07	0.89 ± 0.08
ESR, mm/h	1.0 ± 0.0	1.0 ± 0.0
Platelets, G/l	373.5 ± 10.13	$278.0 \pm 9.92^*$
Leukocytes, G/l	13.1 ± 0.29	$10.6 \pm 0.23^*$
Leukocyte formula		
Basophils, %	0.0 ± 0.0	0.0 ± 0.0
Eosinophils, %	1.0 ± 0.3	0.5 ± 0.5
Rod-nucleated, %	0.0 ± 0.0	0.0 ± 0.0
Segmented nuclear, %	57.0 ± 4.5	52.5 ± 6.3
Lymphocytes, %	41.5 ± 3.8	45.0 ± 4.7
Monocytes, %	0.5 ± 0.5	2.0 ± 1.0

Note: * – $P < 0.05$ in compare to the group of ewes with singles.

Table 4 – Biochemical indicators blood (M ± m)

Indicators	Ewes with singles	Ewes with twins
Total protein, g/l	56.7 ± 3.68	55.2 ± 2.35
Albumins, g/l	31.5 ± 1.07	29.1 ± 0.98
Globulins, g/l	25.2 ± 0.78	26.1 ± 1.06
Alb/Glob ratio.	1.24 ± 0.12	1.11 ± 0.14
Urea, mmol/l	2.2 ± 0.13	4.2 ± 0.25 **
Creatinine, μmol /l	74.5 ± 3.05	62.5 ± 2.81
AST, U/l	127.1 ± 4.83	143.5 ± 5.49
ALT, U/l	17.1 ± 0.24	17.5 ± 0.17
Alkaline phosphatase, U/l	73.5 ± 2.03	50.4 ± 2.15
Glucose, mmol/l	2.6 ± 0.12	2.7 ± 0.16
Total calcium, mmol/l	2.7 ± 0.17	2.5 ± 0.09
Inorganic phosphorus, mmol/l	1.5 ± 0.10	1.7 ± 0.13

Note: ** – $p < 0.01$ in compare to singles.

In the group of ewes with one lamb, the level of total protein was 2.7% higher, while the albumin content in the ewes of the first group was 31.5 ± 1.07 g/l, and in the second – 29.1 ± 0.98 g/l (the difference was equal 8.2%).

A significant increase in the urea level was also noted in the group of ewes with twins (+90.9%), and the creatinine index had a tendency to decrease compared to the other group. A weak tendency to decrease the content of total calcium was observed in ewes that gave birth to twins. No significant differences were found for other biochemical indicators studied.

Discussion

One of the priority areas of sheep breeding development is the development of programs for improving breeds, especially newly created ones, through the rational use of their genetic resources (Iovenko, 2017; Zharuk et al., 2020). Effective management of meat sheep farming is ensured by increasing the level of fertility, preservation and intensive growth of young animals from birth to weaning. This period of lamb growing is primarily determined by the milk yield of ewes (Lesyk et al., 2021; Nel et al., 2023).

Milk production is determined by many factors, the most important of which are the number of lambs born, the level and balance of feeding, as well as providing of proper housing conditions (Dwyer, 2007; Yakovchuk et al., 2021; Černá et al., 2023).

Australian researchers have found that the survival of newborn lambs depends on the ease of lambing, which is determined by live weight and the duration of the embryonic period (Everett-Hincks et al., 2014; Kleemann et al., 2023). For the same litter size and birth to mature size ratio, more fertile genotypes are superior in terms of lamb viability (Gama et al., 1991).

Hereditarily determined parameters of lamb weight at birth and litter size at lambing affect the genetic assessment of the ability of ewes to further feeding of lambs (Everett-Hincks et al., 2014; Kim et al., 2017). It was established that at birth, single lambs naturally had a greater live weight and more intensive growth compared to twins, in ram-lambs by 34.5 %, in ewes-lambs – by 27.1 %. Rams do not always grow faster than ewes in the first month of the suckling period. Twin lambs usually lag behind in development due to competition for milk. Similar results were obtained in the studies of Pomytun and coauthors (2016) where the growth intensity of Prekos lambs was assessed during the first 20 days of the neonatal period. The results obtained in present study are in concordance with other reports on daily growth differentiation in respect to single and twin lambs. Particularly, observed data demonstrated that ewes-lambs born as singles had the highest

growth intensity while average daily growth rates by 11.4 % higher compared to single ram-lambs.

The composition of small ruminant milk depends on genotype, reproduction technology, standardized feeding, agroclimatic and socio-economic environment, as well as on farming methods (Dettori et al., 2017; Skrepets et al., 2021; Li et al., 2022). The results of the studies showed that there were no significant differences in the chemical composition of milk between ewes with different numbers of newborn lambs. The ratio of average fat to protein in milk of ewes with single lambs and ewes with twin lambs was 0.95 and 0.93, respectively. However, several reports demonstrated that the fat/protein ratio was usually higher – 1.3–1.4 (Moatsou & Sakkas, 2019).

Some results also indicate that a fairly low amount of milk fat at the beginning of lactation is quite normal (Stapay et al., 2016; Fotina & Zazharska, 2016). This is confirmed by the results of research carried out by Pokhyl & Mykolaichuk (2020) that was focused on the milk fat of Romanov sheep. Their results have shown that fat and protein content were variable within 6.45–6.60 % and 4.78–5.20 %, respectively.

Lactose, the most stable component in milk, the content of which was at the level of 4.77–4.78 %. It plays a major role in maintaining a constant pressure in the blood-milk system. There is a close relationship between the biochemical parameters of milk and blood and the metabolic status of lactating animals. Other authors reported that milk has great potential for predicting blood metabolite levels and metabolic status not only in cows but also in other animal species (Andjelić et al., 2022).

The results of hematological blood analysis allow to take important data to assess the health status of animals, the level of metabolic processes and the activity of the body's protective systems. Keeping that in mind, the determination of hematological blood parameters and their role as an integral indicator of the course of redox reactions in the body of sheep of newly developed breeds is an urgent need (Zharuk et al., 2020).

Studies have shown a slight increase in erythropoiesis in ewes with twin lambs, which may indicate a higher level of oxidative processes. This pattern is indicated, in particular, by the results of studies obtained by Korh & Boyko (2016) when studying the morphological composition and state of natural resistance of the blood of lambs of different genotypes.

Blood leukocyte composition is determined by the complex coordination of leukopoiesis and the speed of leukocyte destruction. Thanks to the redistribution mechanism, even minor factors can change the content of leukocytes in the blood. The ewes with single lambs had higher leukocyte counts. We consider these facts as a consequence of the higher immunological reactivity of

the organism, which creates favorable conditions not only for the rapid growth of the offsprings, but also their increased resistance to diseases.

Changes in metabolic parameters in group of ewes with twins, in particular, a decrease in albumin levels, may indicate impaired protein synthesis in the liver or increased use of blood albumin by peripheral tissues (Kraevskiy et al., 2022). The marked increase in urea levels in the 2nd group of ewes can be considered as a consequence of higher protein intake from the diets, since higher milk production leads to higher feed consumption needs (Hassoun et al., 2021). The enhancement of metabolic processes in these animals is also evidenced by higher AST activity, since the level of enzyme release from hepatocytes depends on the functional activity of the organ and is observed, in particular, in cows with higher milk yield (Katica et al., 2024). It is natural that the higher milk productivity of ewes with twins also has a certain effect on the level of total calcium in the blood serum, which decreases, apparently due to its greater excretion with milk.

Differences in protein and mineral metabolism indices, as well as the changes in enzymatic activity, require further analysis to find out the possible causes of these deviations and their impact on the general condition of the animals.

Conclusions

Established differences between ewes in lamb growth rate, milk yield depending on the number and type of lambs born may be associated with the level of stress or metabolic adaptation. High lamb growth rates in the first 20 days will allow for measures aimed at intensive rearing of young stock. Particular attention should be paid to ewes giving birth to twins. The obtained results of blood morphological and biochemical composition in ewes in the most intense phase of the suckling period have applied value in the development of breeding measures aimed at predicting a productivity of ewe farming.

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Conflict of interests

The authors of this article declare no conflict of any interests or personal relationship regarding this manuscript.

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