



AGRICULTURAL ACADEMY



Research Institute of Mountain Stockbreeding and Agriculture - Troyan

Scientific department «ANIMAL HUSBANDRY IN THE MOUNTAIN REGIONS»

Genoveva Savova Georgieva

**Phenotypic and genotypic parameters of Romanov sheep
breed reared under contemporary conditions in Bulgaria**

A B S T R A C T

**of a dissertation for the acquisition of the educational and scientific degree
"DOCTOR"**

In the professional field: 6.3. Animal husbandry

Field of higher education:

6. Agricultural sciences and veterinary medicine

Doctoral program: Sheep and goat breeding

Academic Supervisors:

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The PhD thesis is structured in IX sections, spanning 132 pages, and includes 19 tables, 31 figures, and 8 photographs. The bibliography comprises 271 literary sources, of which 73 are in Cyrillic and 198 are in Latin script.

The numbering of the tables in the thesis and the abstract is not identical, whereas the numbering of the figures is the same.

The thesis was discussed and proposed for public defense at a meeting of the primary research unit of the Department of Animal Husbandry in the Mountain Regions at the Research Institute of Mountain Stockbreeding and Agriculture (RIMSA) – Troyan, held on January 15, 2026.

The materials related to the thesis defense are available at the Scientific Secretary's office of the Research Institute of Mountain Stockbreeding and Agriculture – Troyan.

Scientific Jury:

- **Prof. Nikolay Tsvetanov Markov, PhD**
- **Prof. Radoslav Ivanov Slavov, DSc**
- **Assoc. Prof. Penko Naydenov Zunev, PhD**
- **Assoc. Prof. Penka Yonkova Yonkova, PhD**
- **Assoc. Prof. Todor Iliev Tsonev, PhD**

I wish to express my most sincere gratitude and appreciation to my academic supervisors, Assoc. Prof. Tsvetomira Petkova Bancheva, PhD, and Prof. Svetoslava Todorova Eneva-Stoycheva, PhD, for their patience, professionalism, and unwavering support throughout the entire preparation of this PhD thesis!

I would also like to thank the Department of Animal Husbandry in the Mountain Regions, as well as the Management of the Research Institute of Mountain Stockbreeding and Agriculture – Troyan.

Finally, I extend my heartfelt gratitude to my family for their support.

INTRODUCTION

Sheep breeding is a traditional livelihood for Bulgarians and a vital production sector for the country's economy. With the wide variety of products they provide, sheep play a central role in Animal Husbandry. Historically, they were a primary source for the production of clothing and textiles and held significant importance in the carpet industry. Due to economic development, globalization of international trade, and an ever-evolving world, sheep farming has gradually marked a decline, yet sheep have maintained their place in Bulgarian customs and traditions.

On a global scale, there is a growing interest in and a high valuation of ecologically pure food products, as well as goods made from natural materials.

The Romanov sheep breed was established through long-term traditional selection more than two hundred years ago in Russia. Initially, it was valued for its high-quality hides and the remarkable structure of the fleece. Later, the selection focus shifted toward the reproductive characteristics of the ewes.

In Europe, the Romanov breed became widespread more than fifty years ago, which was also when it was introduced to our country. Today, it serves as a repository for valuable and unique genes that autochthonous Bulgarian sheep breeds do not possess.

The Romanov breed in Bulgaria has undergone both a period of ascent—reared through purebred breeding and utilized in crossbreeding schemes with other breeds—and a period of decline in population numbers.

Currently, interest in the breed is driven by the high prolificacy of the ewes, which can be utilized to improve the economic traits of other sheep breeds with lower fertility. The high survival rate of newborn lambs is associated with higher meat productivity and economic profitability achieved per ewe within a fiscal year.

Research concerning the milk and meat productivity of Romanov sheep is limited, and over the recent decades in Bulgaria, up-to-date data has been practically non-existent. In the available literature, information regarding the milk and colostrum of the breed is scarce. Therefore, the present study focuses on certain phenotypic and genotypic characteristics of animals of the Romanov breed reared under the contemporary conditions of Bulgaria (the Fore-Balkan region), presenting for the first time in the country results characterizing their colostrum.

I. AIM AND OBJECTIVES OF THE STUDY

The aim of the present study is to monitor the dynamics of the primary phenotypic and genotypic parameters of the Romanov sheep breed reared under the contemporary conditions of Bulgaria.

To achieve this aim, the experimental work was organized through the implementation of the following objectives:

- 1. Dynamics of live weight in relation to age.**
- 2. Milk productivity and composition of colostrum and milk from the Romanov sheep breed.**
- 3. Determination of the fattening abilities and meat quality traits of male and female lambs.**
- 4. Exterior measurements of animals at different ages.**
- 5. Wool yield and wool fineness.**
- 6. Reproductive indicators of ewes from the Romanov breed.**

II. MATERIAL AND METHODS

The study was conducted during the period 2022–2024. The research included 345 lambs, 172 ewes, and 8 rams of the Romanov breed, raised at the Scientific and Experimental Base of the Research Institute of Mountain Stockbreeding and Agriculture in Troyan, located in the fore-mountainous region of Central Northern Bulgaria.

The animals are raised under a barn-and-pasture system, being kept on enclosed pastures during the day from May to October. Breeding is carried out via harem mating through natural service by the sires, with the breeding season beginning in mid-June according to a pre-established mating plan. Lambing commences in mid-November.

Immediately after parturition, the ewe and the newborn lambs are separated from the flock into individual pens. Within 24 hours of lambing, the newborns are weighed, and their weight, sex, and birth type (single, twin, etc.) are recorded.

Around the tenth day, the ewes and their lambs are moved to group pens. The lambs are introduced to high-quality meadow hay and concentrated (supplementary) fodder, with suckling allowed *ad libitum*. Between the twentieth and thirtieth day, the lambs are separated from the mothers and are allowed to suckle twice daily, in the morning and evening.

Photographs of typical animals of the breed (Photos 1–4).



Photo 1. Hoggets



Photo 2. Ewes



Photo 3. Ram



Photo 4. Lambs

Objective 1. Dynamics of live weight in relation to age

To monitor the changes in individual development, the live weight is recorded each year of the study at birth and in the morning before foddering at 10, 20, 30, 60, and 90 days, as well as at 6 months, 18 months, and 2.5 years of age. The lambs are weighed within 24 hours after birth using an electronic scale with a precision of 0.1 kg and are marked with individual ear tags with sequential numbering.

The average daily gain (C) is determined for the periods between weighings using the following formula:

$$C = \frac{W_t - W_0}{t_2 - t_1}$$

W_t is the live weight at the end of the period, kg;

W_0 is the live weight at the beginning of the period, kg;

t_2 is the age of the animals at the end of the studied period;

t_1 is the age of the animals at the beginning of the period.

Objective 2. Milk productivity and composition of colostrum and milk from the Romanov sheep breed

To monitor changes in the physicochemical composition, colostrum samples are obtained by hand-milking the ewes up to the 24th hour (Day I), from the 24th to the 48th hour (Day II), and from the 48th to the 72nd hour (Day III) after parturition. The milked colostrum is strained and placed in sterile 100 ml containers. Immediately after collection, the samples are transported for analysis to the Analytical Laboratory at RIMSA, where the primary physicochemical indicators are determined – solids-not-fat (%), dry matter (%), fat content (%), protein (%), and lactose (%) using a "Laktoskan LW" milk analyzer (Milkotronic Ltd.).

The total number of milk samples studied over the three-year period is 406.

To determine the milk yield for the lactation period and the physicochemical indicators of the milk, four testings (controls) are conducted during each separate year of the study.

The lactation milk yield of the ewes was determined for a 120-day period. The quantity of milk is measured in volume units (ml). The milk yield of each ewe for the testing day is calculated by multiplying the quantity of milk obtained during the individual morning control by two. This provides the daily milk yield. Multiplied by the number of days in the control period, the total quantity of milk for that period is obtained.

The milk yield of the ewes for the 120-day lactation period is calculated as the sum of the milk yields from the individual control periods for each ewe.

To determine the physicochemical indicators, individual milk samples are placed in 50 ml containers and transported to the laboratory.

The milk quality was tested in the Analytical Laboratory at RIMSA using a "Laktoskan LW" milk analyzer (Milkotronic Ltd.), where the following indicators were analyzed from the individual milk samples:

- Solids-not-fat (%)
- Dry matter (%)
- Fat content (%)
- Protein (%)
- Lactose (%)

During all milk testings, a composite milk sample was taken and analyzed for titratable acidity, casein, NCP %, density, and calcium.

• Titratable acidity (°T) – determined using the Thörner method. In a 100 ml beaker, 10 ml of milk is measured; 20 ml of distilled water is added using a graduated cylinder, along with 3-4 drops of phenolphthalein via pipette, and then stirred. The resulting mixture is titrated with 0.1n NaOH dropwise under constant agitation until a faint pink color appears.

The titratable acidity is expressed in °T (Thörner degrees) and is calculated using the following formula:

$$\text{Titratable acidity} = A \cdot F \cdot 10$$

Where:

A – The volume of 0.1n NaOH consumed, ml

F – The factor of the 0.1n NaOH solution

Calcium – Ca (mg%)

To determine the Ca content in milk, it is first necessary to establish the milk density. Using a pipette, 2 ml of milk is measured into a 200 ml beaker and diluted with 93 ml of bidistilled water. To the diluted milk, 5 ml of 4n NaOH and 0.2 g of mixed indicator are

added. The mixture is titrated rapidly with 0.05 mol Complexon III until a red-pink color is obtained. The quantity of Ca is expressed in milligram percentages (mg%), calculated using the following formula:

$$Ca \text{ (mg\%)} = (0.1002 \times ml \text{ Complexon consumed}) / (\text{Measured density})$$

- NCP (%) and Casein (%) – according to Peichevski.

100 ml of milk is heated in a water bath to 45°C. 10 ml of 10% H₃PO₄ (phosphoric acid) is added, causing the sample to coagulate. The sample is filtered through filter paper (388). The resulting filtrate is analyzed using a "Laktoskan LW" milk analyzer (Milkotronic Ltd.).

Calculations:

NCP % (Non-cellular protein substances) – the value of the protein contained in the filtrate.

Casein – obtained as the difference between the total protein content in the milk and the protein established in the filtrate.

Objective 3. Determination of the fattening abilities and meat quality indicators of male and female lambs

To determine the fattening abilities and meat quality indicators of Romanov lambs, an experiment was conducted under an intensive raising system at the Scientific and Experimental Base of RIMSA – Troyan. A total of 12 lambs were included in the experiment. Two groups were formed: 6 male and 6 female lambs, all born as triplets (Photos 5 and 6).



Photo 5. Male lambs for fattening



Photo 6. Female lambs for fattening

The lambs were raised according to the technology described above until they reached 60 days of age and a weight of 14–16 kg, after which they were weaned from the mothers and adapted for one week to the new foddering and management conditions. The groups were formed using the analog method based on weight and age at the start of the experiment, birth type, and sex of the lambs.

The animals were raised on deep litter with constant access to water, in loose housing with 3 animals per pen, in accordance with Appendix № 3, Art. 10 of Ordinance № 44 of 2006 regarding veterinary and zoo-hygienic requirements for livestock facilities (SG, amended and supplemented, № 56 of 2023). The experimental animals were fed *ad libitum* according to a ration pre-adjusted to their age, satisfying their nutritional requirements. The daily ration consisted of a concentrated (supplementary) fodder for lambs, "Starter 23-1," certified and produced by "MELHRAN" Ltd., Stara Zagora, containing 1.25 FUG and 105.00 g IPD per 1 kg, and ground meadow hay containing 0.48 FUG and 54.40 g IPD per 1 kg. The consumption of fodder and hay was recorded daily based on the difference between the

amount provided and the residues on the following day. Live weight was measured at the start of the experiment and controlled every 15 days by weighing with an electronic scale. The animals were fattened for a period of 60 days.

The chemical composition of the fodder used is presented in Table 1.

Table 1. Chemical composition of the fodder used

Indicator	Crude Protein	Crude Fiber	Crude Fat	Ash	Calcium	Sodium	Phosphorus	Magnesium	Moisture
Fodder, %	18	7.41	2.62	5.7	0.74	0.33	0.57	0.26	12.31
Hay, %	4.47	43.03	0.67	6.19	1.01	-	0.19	-	8.52

The absolute gain (A), kg was calculated using Microsoft Excel 2019 according to the formula of Brody (1945).

$$A=W_t-W_0$$

Where W_t is the live weight at the end of the period, kg; W_0 – the live weight at the beginning of the period, kg. The average daily gain (C) is determined for the periods between weighings according to the formula:

$$C = \frac{W_t - W_0}{t_2 - t_1}$$

Where t_2 is the age of the animals at the end of the studied period, and t_1 is the age of the animals at the beginning of it.

At the end of the fattening period, a slaughter analysis was performed to determine the meat quality and establish the carcass parameters. A total of 6 lambs were slaughtered—3 male and 3 female triplets, respectively—with weights close to the group average. This was conducted in accordance with the requirements of Ordinance № 22 of December 14, 2005, "On minimizing the suffering of animals during slaughter or killing." On the day of slaughter, the lambs were weighed to establish the live weight before slaughter. After cooling at a temperature of 2–4°C for 24 hours, the carcasses were weighed again to determine the cooling losses and the weight of the cold carcass. The carcasses were split into two equal halves through the center of the spine.

Linear measurements were performed on the left half of the carcass according to the methodology of Zahariev and Pinkas (1979).

- **Carcass length** – measured from the anterior end of the pelvic symphysis (*symphysis pelvis*) to the middle of the anterior edge of the first rib.

- **Leg length** – measured with a tape measure from the point of cut at the tarsal joint to the anterior end of the pelvic symphysis (*symphysis pelvis*).

- **Chest width** – measured with a tape at the level of the 5th thoracic vertebra from the ventral side of the vertebral column at the caudal side of the vertebra itself, to the xiphoid cartilage of the sternum on the ventral side.

The left half of the carcass was weighed and dissected into 6 primal cuts: neck, shoulder, breast, loin, leg, and flank.

To establish the weight ratio between the cuts, each part of the carcass dissection was weighed separately using an electronic scale. To determine the ratio between bones, muscles,

and fat, each cut was deboned, and the components (bones, muscles, and fat) were weighed individually. From these data, the meat-to-bone ratio (fleshiness coefficient) was calculated.

The pH at the 45th minute (pH1) and pH at the 24th hour (pH24) post-slaughter were determined for the *m. Longissimus thoracis et lumborum* (at the level between the 11th and 13th thoracic vertebra) and the *m. Semimembranosus* using a pH meter – pH 3110 SET 2-Wissenschaftlich Technische Werkstätten. Samples from both muscles were taken from the left halves of each slaughtered lamb.

To determine the meat quality, the following technological indicators were analyzed:

- pH
- WHC of *m. Longissimus thoracis et lumborum* and *m. Semimembranosus* was examined according to the methodology of Grau and Hamm (1953), with modifications by Petrov (1982).
- Meat tenderness was determined using a penetrometer, taking the average value of 10 consecutive readings. It is measured in penetrant degrees (°P).
- Meat color was determined using an instrumental method with a WALCOM CM-200S colorimeter, recording the primary coordinates L, a, b*.

Where:

- L – Lightness*
- a – Redness*
- b – Yellowness*

A chemical analysis of the meat was also performed at the Meat and Milk Laboratory of the RIMSA – Troyan, which included the following indicators:

- Moisture %
- Protein %
- Fat %
- Ash %

The moisture content in the meat was determined using the gravimetric method. The fat content in the meat was established by ether extraction using the Soxhlet method. The protein content in the meat was determined by the Kjeldahl method.

Task 4. Exterior measurements of animals at different ages

Exterior measurements were carried out on animals at the age of 30 days, 90 days, 9 months, 18 months, and 2.5 years (Tyankov et al., 2000).

Using a **Lydtin's measuring stick** for small ruminants, the following indicators were measured:

- **Height at withers and sacrum** – measured at the highest part of the withers and the sacrum.
- **Chest depth** – the distance from the most prominent part of the withers to the sternum behind the shoulders.
- **Chest width** – the distance between the most laterally prominent parts of the body behind the shoulders.
- **Oblique body length** – from the most prominent forward part of the shoulder joint to the most prominent backward part of the ischium.

Using **Wilkins' calipers**, the following were established:

- **Rump width at the hip bones** – the distance between the most laterally prominent parts of the hip bones (*Tuber Coxae*).
- **Rump length** – from the most prominent forward part of the hip bone (*Tuber Coxae*) to the most prominent part of the ischial tuberosity (*Tuber Ischii*).

Head length – the distance from the occipital crest (poll) to the muzzle (nasal mirror).

Head width – the distance between the most laterally prominent parts of the orbital arches (eye orbits).

Using a **measuring tape**:

- **Chest circumference** – the tape passes behind the shoulders.
- **Cannon perimeter** – measured at the upper third of the withers.

Task 5. Wool yield and wool fineness

The shearing of the Romanov sheep (Photo 7) in the studied flock is performed once a year in May. A total of 59 wool samples were obtained during shearing from ewes and rams of different ages. The weight of the fleece (greasy wool) was measured using an electronic scale with an accuracy of 0.05 kg. Wool fineness was also determined, with samples taken from the shoulder and leg topographic regions.

The fiber diameter was determined in a laboratory using an optical method and measured in micrometers (μm) using a lanometer (Photo 8). The wool samples were cleaned of mechanical impurities and washed. A small bundle of wool fibers is taken and twisted into a wick; it is cut through the middle, and from the remaining half, short sections (snippets) with a length of about 0.5 mm are cut.

A section of the wick length is selected that shows no thinning due to external factors (hungry wool), such as lactation or pregnancy. A drop of glycerin is placed on a microscope slide, and a portion of the fiber snippets are mixed into it using a glass rod.

The thickness of at least 100 down fibers and at least 40 guard fibers is recorded. The class interval of the wool quality is aligned with the scale divisions in μm , and the average thickness of both types of fibers is calculated.

The wool was analyzed in the Wool Science Laboratory of the Association (ORTSRMPO) – Troyan.



Photo 7. Shearing of Romanov ewes



Photo 8. Determination of fiber diameter

Task 6. Reproductive performance of Romanov sheep

The female animals are bred for the first time at 11–12 months of age. To establish the reproductive performance of the ewes, the conception rate, biological fecundity, and economic prolificacy were calculated.

- The conception rate was calculated as a percentage, representing the ratio between the number of pregnant ewes and the number of inseminated ewes.
- Biological fecundity of the flock was determined as the ratio of the number of live-born, stillborn, and aborted lambs to the number of lambed ewes.
- Economic prolificacy was calculated as a percentage, representing the ratio of live-born lambs to the total number of ewes in the flock present as on 01.01.

Statistical processing was performed using Microsoft Excel. The data were processed using the methods of variational statistics. The significance of the influence of factors was determined by the values of Fisher's F-criterion, and the significance of the differences between the studied groups was determined via Student's t-test, using the Data Analysis statistical package in Microsoft Excel 2021.

III. RESULTS AND DISCUSSION

1. Live weight dynamics according to age

Figures 1 and 2 reflect the changes in live weight and average daily gain of the Romanov lambs included in the study.

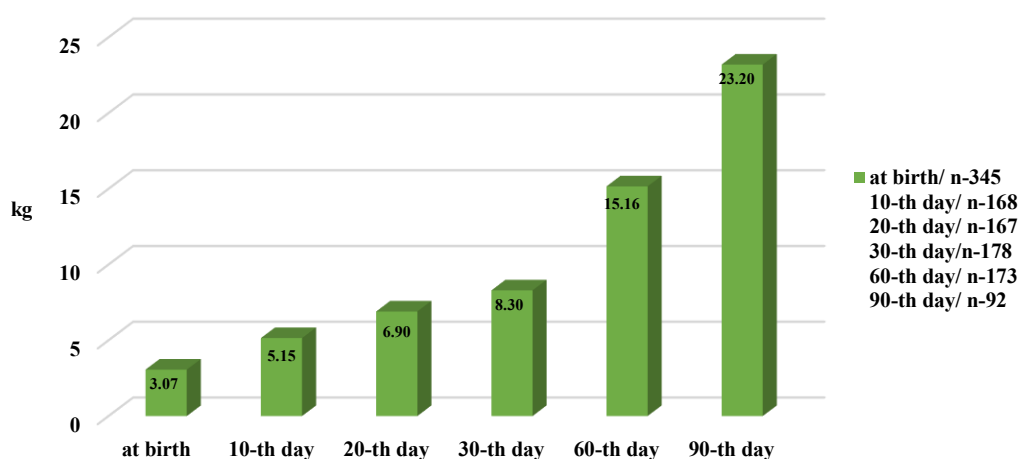


Fig. 1. Live weight of Romanov lambs

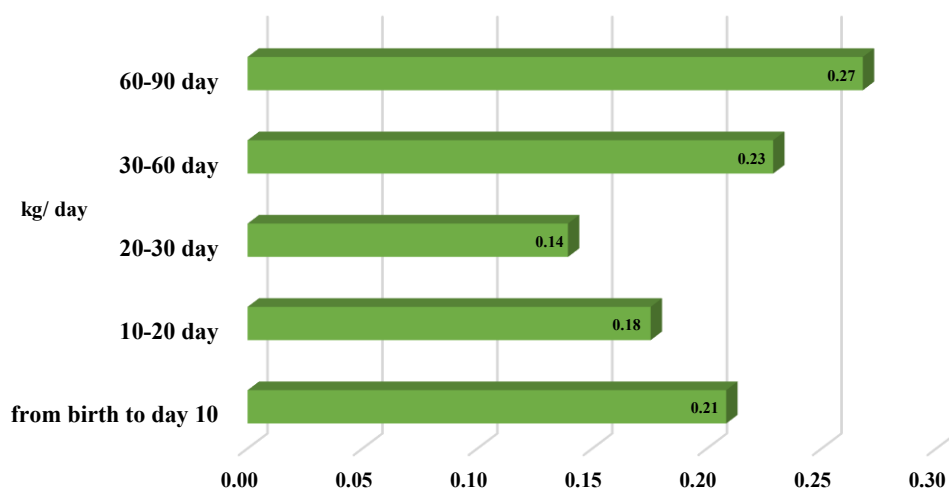


Fig. 2. Average daily gain of Romanov lambs

The average **birth weight** of the Romanov lambs included in our study is 3.07 kg.

As shown in Figure 2, during the first **ten days** after birth, the average daily gain is 0.21 kg/day. Between the **10th** and **20th day**, a decrease of 16.67% is observed; this decline can be attributed to the relocation of the lambs together with the ewes to a common pen. In the following period (**days 20 – 30**), the average daily gain continues to decrease, which coincides with the weaning of the lambs from the ewes.

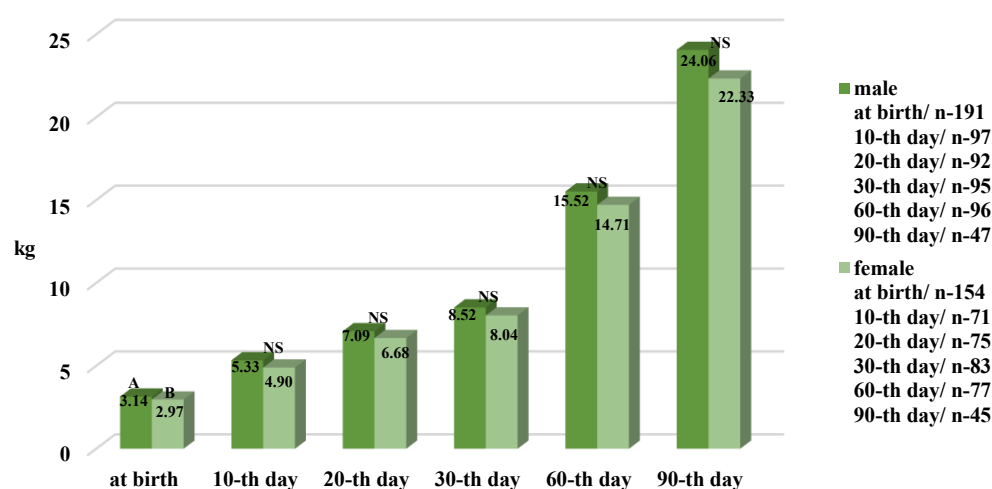
The average live weight **at 30 days** of age for the Romanov lambs included in our study is 8.30 kg. From birth to the thirtieth day, the live weight increases by 5.23 kg or 170.36% (Fig. 1). Up to 30 days of age, the primary weight gain is determined by the continuous intake

of maternal milk, supplemented by the gradual introduction of concentrate fodder and meadow hay.

By the **60th day**, the animals in our study reached a live weight of 15.16 kg. Between the 30th and 60th day, the weight increased by 82.65%, corresponding to an average daily gain of 0.23 kg/day. The higher average daily gain after the 30th day could be attributed to the intake of concentrate fodder.

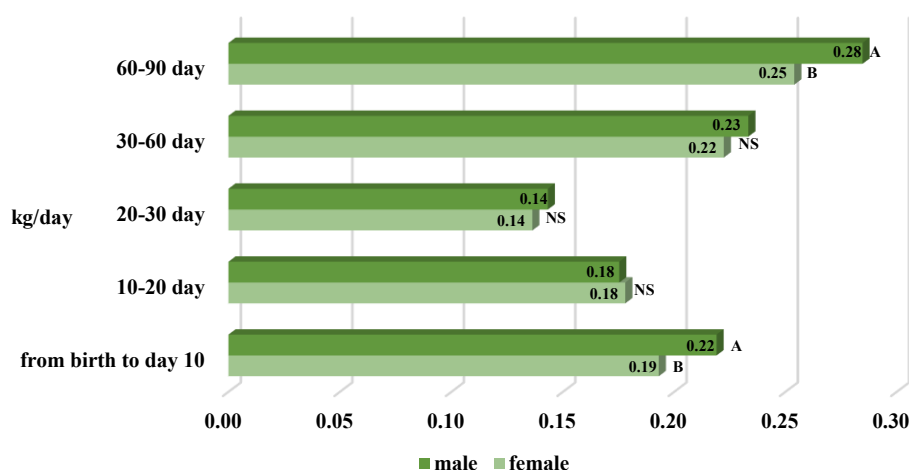
An increase in gain is also observed during the following period from the **60th to the 90th day** (0.27 kg/day), with a difference of 17.39% compared to the previous period; the lambs reached a live weight of 23.20 kg on the **90th day**.

The live weight and average daily gain of male and female lambs during the studied period are presented in **Figures 3 and 4**.



NS – non-significant; Different letters reflect significant differences at $p < 0.05$

Fig. 3. Live weight of male and female lambs

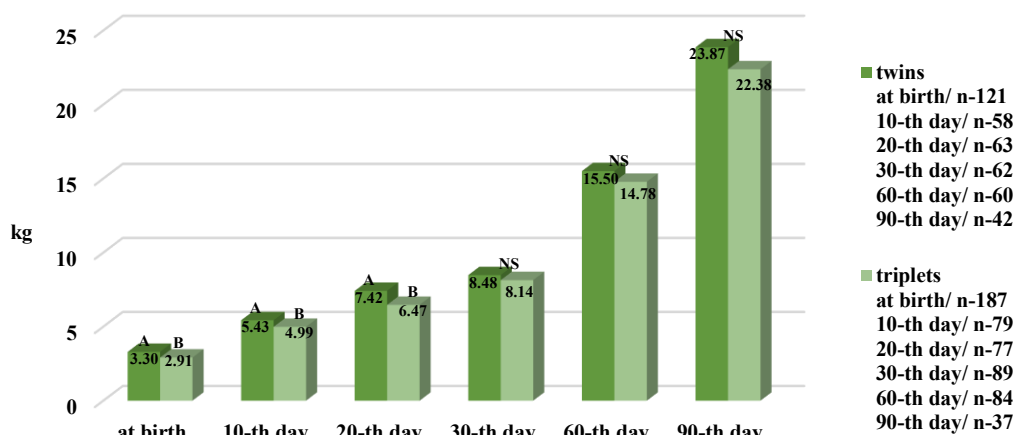


NS – non-significant; Different letters reflect significant differences at $p < 0.05$

Fig. 4. Average daily gain of male and female lambs

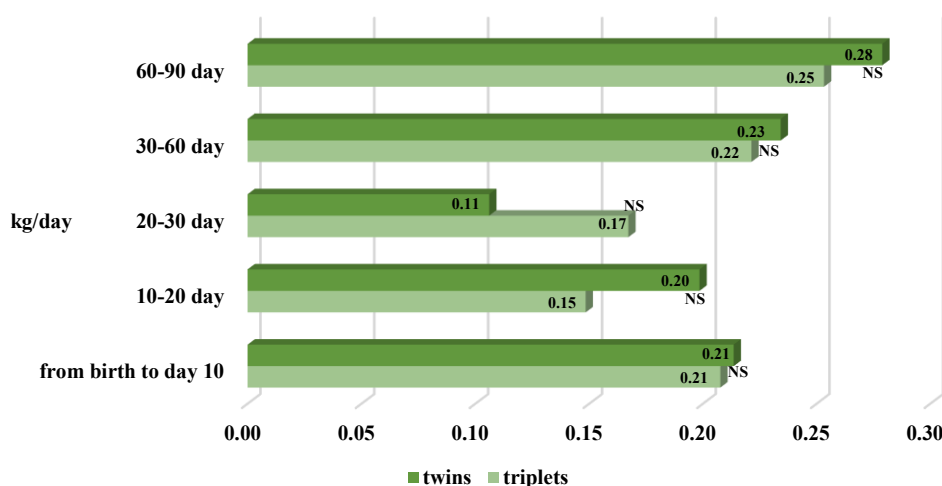
Depending on the **sex**, the average **birth** weight of male lambs is 0.17 kg higher than that of female lambs ($p < 0.05$).

Figures 5 and 6 present the live weight and average daily gain of Romanov lambs according to the type of birth.



NS – non-significant; Different letters reflect significant differences at $p < 0.001$

Fig. 5. Live weight of twins and triplets

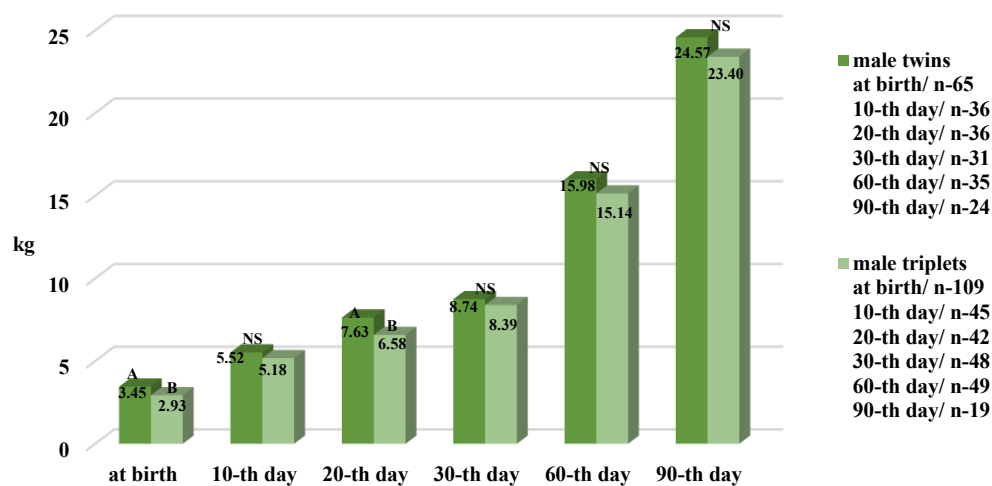


NS – non-significant; Different letters reflect significant differences at $p < 0.001$

Fig. 6. Average daily gain of twins and triplets

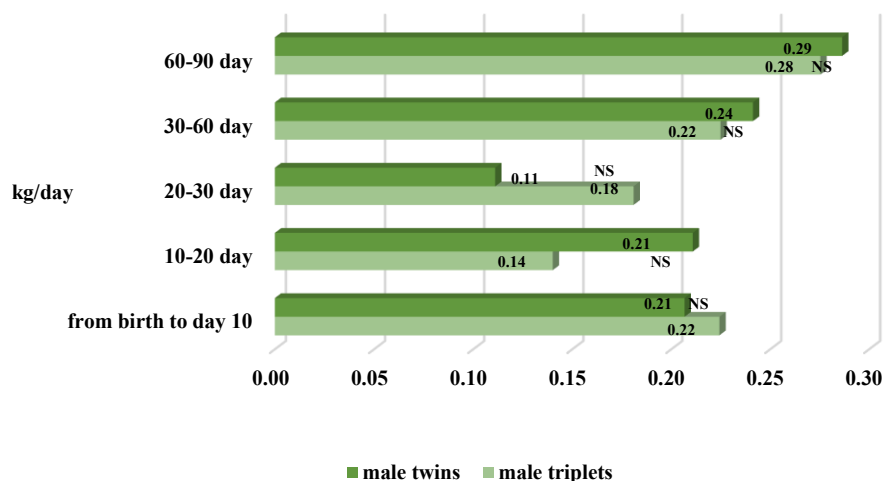
The type of birth has a strongly pronounced significant effect on birth weight. The average birth weight of twins is 13.40% higher than that of triplets ($p < 0.001$).

Figures 7, 8, 9, and 10 present the live weight and average daily gain of male and female lambs with different types of birth.



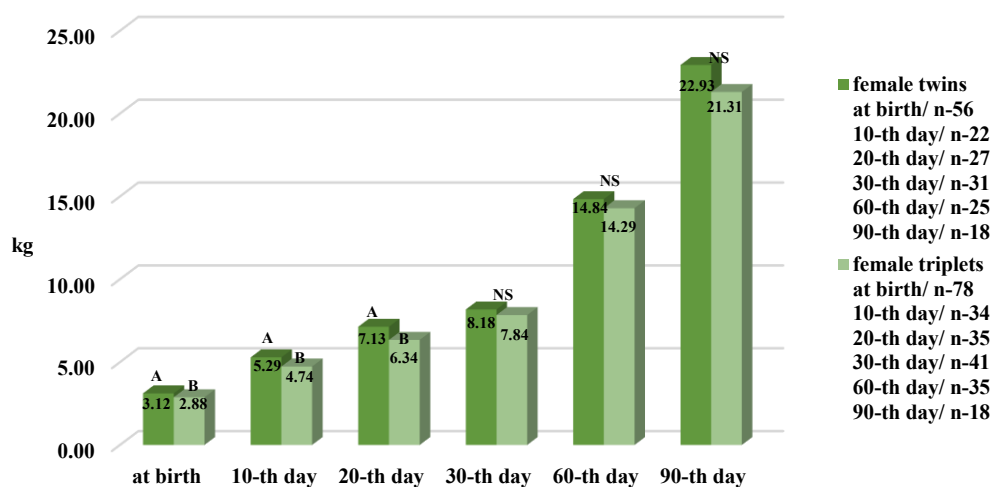
NS – non-significant; Different letters reflect significant differences at $p < 0.01$

Fig. 7. Weight of male twins and triplets



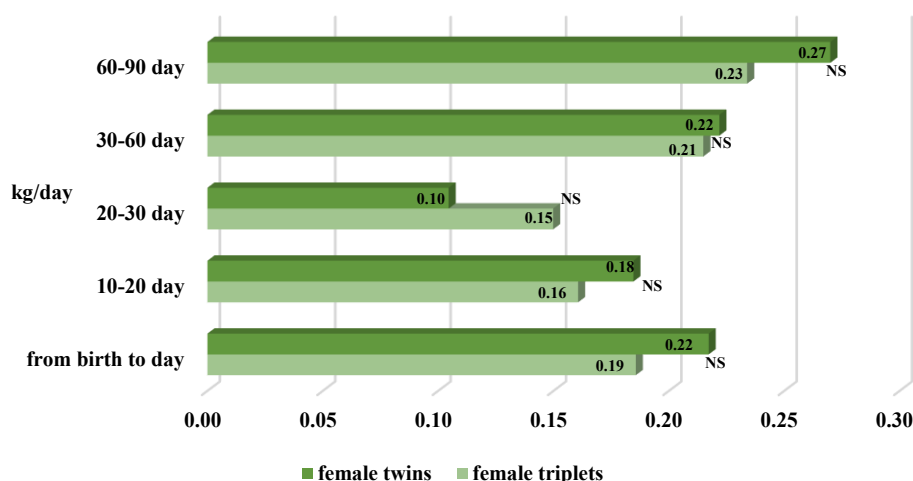
NS – non-significant; Different letters reflect significant differences at $p < 0.01$

Fig. 8. Average daily gain of male twins and triplets



NS – non-significant; Different letters reflect significant differences at $p < 0.01$

Fig. 9. Weight of female twins and triplets



NS – non-significant; Different letters reflect significant differences at $p < 0.01$

Fig. 10. Average daily gain of female twins and triplets

Depending on the sex and type of birth, the highest **birth weight** is observed in male twin lambs, which are 10.58% heavier than female twins. Male twin lambs are 17.75% heavier than male triplets ($p < 0.01$). The lowest average birth weight is recorded for female triplets, which are 8.33% lighter than female twins ($p < 0.01$).

The average live weight on the **10th day** established for all groups of animals included in the study varies from 4.74 to 5.52 kg. Male lambs are 8.78% heavier than females, and the average weight of twins exceeds that of triplets by 8.82% ($p < 0.001$).

By the **10th day**, the weight in the group of male lambs increases by an average of 0.22 kg/day, with the lambs reaching an average of 5.33 kg (Fig. 4). According to the type of birth, male twin lambs exceed the average live weight of male triplets by 0.34 kg, while the average daily gain in twins is similar to that in triplets ($p > 0.05$) – Figs. 7 and 8.

In female lambs, the average live weight at **ten days of age** increases by 1.93 kg. The females gain an average of 0.19 kg/day (Fig. 4). Female twin lambs outperform female triplets at 10 days of age by 0.54 kg ($p < 0.01$) (Figs. 9 and 10).

At **twenty days of age**, male lambs continue to maintain a higher live weight than females. From birth to twenty days of age, male lambs increased their weight by 3.95 kg or 125.79%. During the same period, female lambs increased their weight by 3.71 kg, which is 124.92% (Figs. 3-4).

At this age, twins are 14.68% heavier than triplets, with twins gaining an average of 33.33% more per day than triplets ($p < 0.001$) (Figs. 5-6).

By **thirty days of age**, the average live weight of male Romanov lambs reaches 8.52 kg, while female lambs reach 8.04 kg, with a difference of 6% again in favor of the males ($p > 0.05$). The average daily gain between the **20th and 30th day** in both groups is 0.14 kg/day (Figs. 3-4).

The average weight of twins exceeds that of triplets by 4.18% ($p > 0.05$) (Figs. 5-6). At the same age, a higher average daily gain is recorded for both male and female triplets compared to male and female twins ($p > 0.05$); however, this does not compensate for the difference in live weight, and the twins maintain their superiority.

By the **60th day** after birth, male Romanov lambs reach an average live weight of 15.52 kg and an average daily gain of 0.23 kg/day. The live weight of male lambs increases by 6.86 kg from the previous period. Male lambs are 5.5% heavier than females, also exhibiting a 4.5% higher average daily gain compared to female individuals. At the same age, female

Romanov lambs reach a weight of 14.71 kg and an average daily gain of 0.22 kg/day. From the **30th to the 60th day**, female lambs increase their weight by an average of 6.67 kg (Figs. 3-4).

In contrast to the previous period, the average daily gain in twins is higher than that in triplets. Male twins outperform male triplets by an average of 5.6% ($p > 0.05$), with their daily gain being 0.02 kg/day higher ($p > 0.05$).

The weight of female twins is 3.85% higher than that of female triplets.

At **ninety days of age**, the average live weight in the group of male lambs increases by an average of 0.28 kg/day, reaching 24.06 kg. Male lambs are 7.7% heavier than females ($p > 0.05$). By **90 days of age**, female lambs have increased their weight by 7.62 kg since the previous weighing, with their average daily gain reaching 0.25 kg/day during this period.

The average weight of twins exceeds that of triplets by 6.7% ($p > 0.05$). Male twin lambs exceed the average live weight of male triplets by 1.17 kg, while the average daily gain between the **60th and 90th day** in male twins is 3.6% higher than in triplets. At the same age, female twin lambs outperform female triplets by 1.62 kg ($p > 0.05$).

The highest average daily gain was achieved between the **60th and 90th day** across all groups of lambs, after which the growth intensity decreases.

Figure 11 presents data on the live weight of female Romanov animals aged from 6 months to 2.5 years.

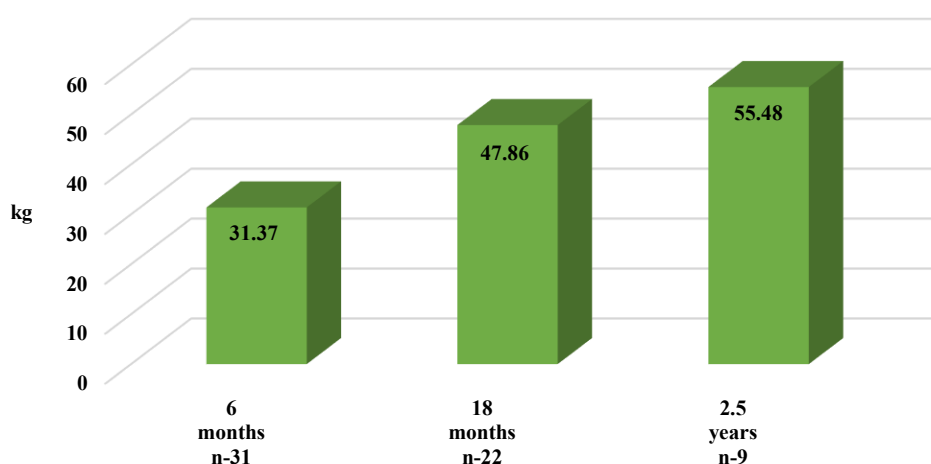


Fig. 11. Average weight of female animals at 6, 18 months, and 2.5 years of age

At **six months of age**, female animals reach an average live weight of 31.37 kg. From the 90th day to the 6th month, female hoggets increase their weight by an average of 9.04 kg. The daily gain decreases to 0.10 kg/day.

At **18 months of age**, female animals reach a live weight of 47.86 kg, having increased their weight by 16.49 kg from the 6th to the 18th month. At this age, economic maturity has been reached, but the animals continue to gain weight. At the next control weighing at **2.5 years**, the average live weight reaches 55.48 kg (Fig. 11).

Our observations are supported by data from Tsochev et al. (2018), according to which, after 30 days of age, a trend toward equalization of live weight between Romanov lambs of different birth types is observed. This indicates good compensatory growth abilities of triplet lambs. Twins maintain an advantage, demonstrating a higher live weight compared to triplets.

2. Milk productivity and composition of colostrum and milk from Romanov sheep

2.1 Analysis of colostrum

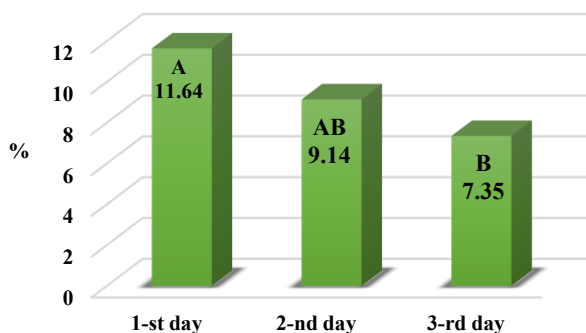
Table 2 reflects the changes in the colostrum parameters of Romanov ewes during the first three days after lambing.

Table 2. Physicochemical parameters of colostrum

Year of study	I st year			II nd year			III rd year		
	$\bar{x} \pm S\bar{x}$			$\bar{x} \pm S\bar{x}$			$\bar{x} \pm S\bar{x}$		
Day	1-th day	2-nd day	3-rd day	1-st day	2-nd day	3-rd day	1-st day	2-nd day	3-rd day
n	5	9	5	11	15	10	12	11	6
Fat, %	10.78±0.16	8.53±0.27	7.21±0.21	11.18±1.04	8.37±0.66	7.33±0.40	12.41±1.14	8.88±0.75	7.48±0.79
SNF%	17.89±0.12	11.71±0.14	10.52±0.11	19.83±1.27	13.08±0.84	11.01±0.36	20.93±1.59	13.69±0.69	12.51±1.19
Density g/ml	1.0616±0.01	1.0390±0.01	1.0352±0.00	1.0690±0.01	1.0480±0.05	1.0370±0.00	1.0635±0.01	1.0460±0.00	1.0425±0.00
Lactose, %	7.99±0.12	5.21±0.14	4.69±0.11	8.87±0.57	5.85±0.38	4.91±0.16	9.33±0.71	6.13±0.33	5.79±0.64
Salts, %	1.30±0.12	0.84±0.16	0.75±0.12	1.44±0.09	0.95±0.06	0.79±0.03	1.51±0.12	0.99±0.06	0.93±0.09
Protein, %	8.50±0.12	5.57±0.14	5.01±0.11	10.84±1.48	6.24±0.39	5.23±0.17	9.93±0.76	6.54±0.34	5.74±0.64
DM, %	28.66±0.10	20.24±0.12	17.73±0.10	31.02±1.89	21.48±1.15	18.34±0.32	34.13±2.55	22.63±0.88	18.34±0.32
pH	6.02±0.05	6.09±0.02	6.15±0.07	6.10±0.02	6.11±0.05	6.12±0.04	6.03±0.05	6.15±0.06	6.20±0.08
Titrateable acidity, °T	53.40±0.16	28.89±0.15	24.20±0.20	42.63±3.12	30.43±1.95	25.44±1.86	47.74±1.56	27.36±1.56	23.83±0.06
Ca, mg%	0.24±0.09	0.25±0.22	0.23±0.06	0.23±0.01	0.20±0.01	0.19±0.01	0.24±0.01	0.24±0.01	0.21±0.01

Figure 12 reflects the changes in the average values of the fat content parameter for the entire study period.

Fat content:

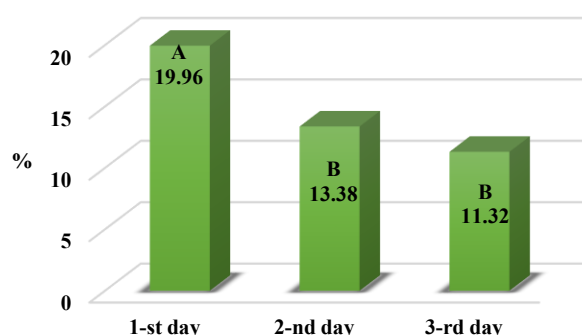


Different letters reflect significant differences at $p < 0.001$.

Fig. 12. Average values for colostrum fat content for the entire period

During the study period, the highest value for the fat content parameter was recorded on the first day after lambing. On the second day, a clearly pronounced decrease in fat content is observed, and during the third day, the values reach their lowest level. The difference between the first and the third day is statistically significant ($p < 0.001$), which indicates the change in colostrum composition during the early postnatal period.

Solids-not-fat (SNF)



Different letters reflect significant differences at $p < 0.001$.

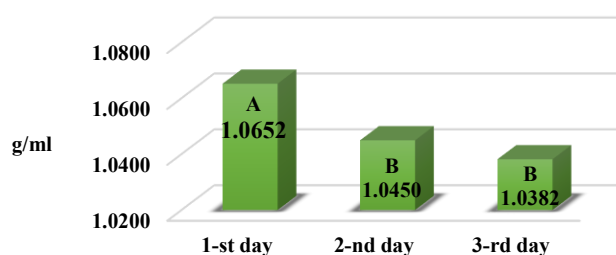
Fig. 13. Average values of colostrum SNF for the entire period

The solids-not-fat (SNF) indicator marks a clearly pronounced decrease from the first to the third day after lambing ($p < 0.001$) (Fig. 13). This dynamic in changes is maintained across all three years, with the highest values always being established on the first day after birth.

The highest value for the SNF indicator was recorded on the first day of the third year of the study, which also corresponds to the highest established fat content for the same period. This indicates that during this year, the colostrum had the highest concentration of total solids and the best nutritional characteristics.

These data confirm our observation of a sharp decrease in colostrum solids-not-fat during the early postnatal period, regardless of the animal species or breed.

Density



Different letters reflect significant differences at $p < 0.001$.

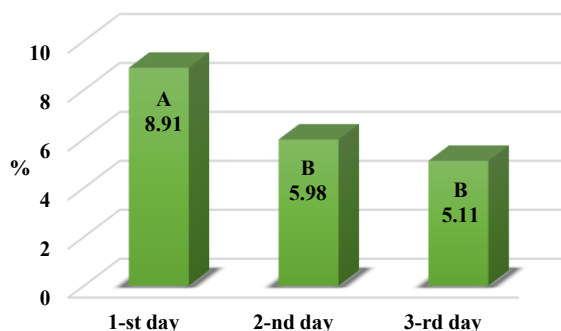
Fig. 14. Average values of the colostrum **density** indicator for the entire period, (g/ml)

In accordance with the dynamics of the other physicochemical indicators, the colostrum density indicator shows a clearly pronounced decrease after the first 24 hours post-lambing (Fig. 14). The highest values are established on the first day, followed by a statistically significant decrease during the second day.

The difference between the first and the second day is 0.0202 g/ml ($p < 0.001$), which indicates the change in colostrum composition during the early postnatal period. Between the second and the third day, a smaller difference is recorded – 0.0068 g/ml ($p > 0.05$), showing a gradual stabilization of the indicator.

The observed decrease in density is directly related to the reduction in the content of total solids, proteins, and minerals, reflecting the transition from concentrated colostrum to milk. The gradual decrease in colostrum density during the early postnatal period is independent of the animal species and breed.

Lactose



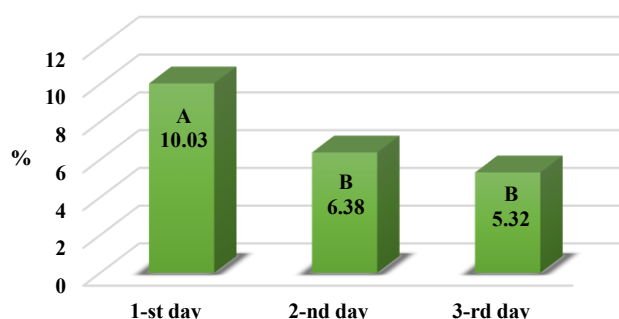
Different letters reflect significant differences at $p < 0.001$.

Fig. 15. Average values of **lactose** in colostrum for the entire period

The lactose content in the colostrum is presented in Figure 15. The analysis shows that this indicator reaches its highest value on the first day after lambing, followed by a significant decrease on the second day ($p < 0.001$). Throughout the individual years, the values of the indicator vary within a wide range across the different collection days. This variability is likely due to individual differences between the animals, seasonal factors, as well as the age and nutrition of the ewes.

Protein

The protein content in the colostrum of the ewes is highest on the first day after lambing, as shown in Figure 16. The high values during this period can be explained by the larger amount of immunoglobulins, as described in the literature. On the second day after lambing, a significant decrease in this indicator is observed ($p < 0.001$). During the third day, the lowest value of the indicator was established, both for the entire study period and when comparing the individual years of observation.



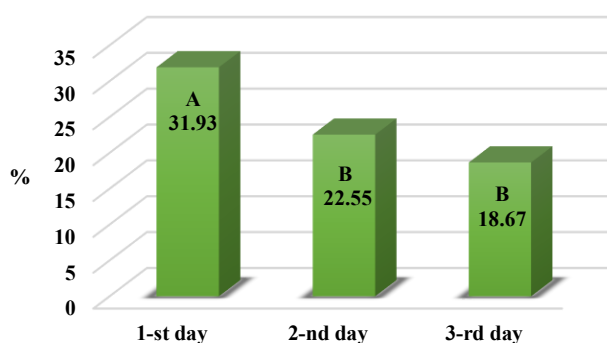
Different letters reflect significant differences at $p < 0.001$.

Fig. 16. Average values of **protein** in colostrum for the entire period

Based on the above, we can summarize that the protein content in colostrum varies significantly between different sheep breeds, with a rapid decrease observed during the first days after lambing, which corresponds to the natural transition from colostrum to milk.

Total Solids

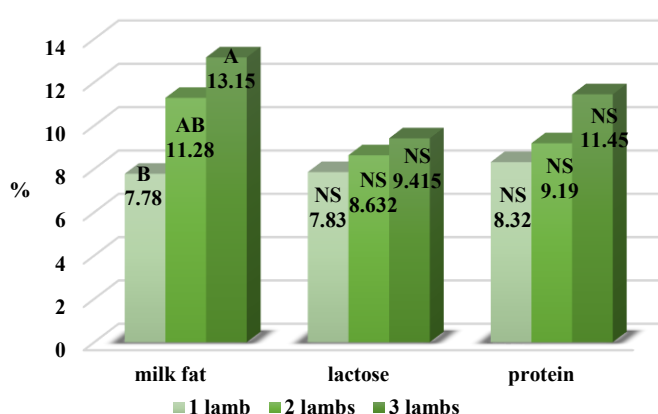
From the first to the third day after lambing, the **total solids indicator** in the ewes' colostrum decreases. The changes in this **indicator** for the entire study period are presented in Figure 17.



Different letters reflect significant differences at $p < 0.001$.

Fig. 17. Average values of **total solids** in colostrum for the entire period

Figure 18 presents the content of the indicators in the colostrum on the first day after lambing, in ewes with a different number of offspring in the litter.



NS – non-significant

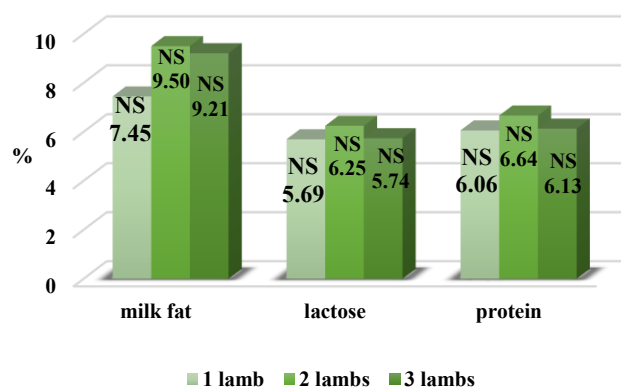
Different letters reflect significant differences at $p < 0.05$;

Fig. 18. Colostrum indicators on the 1st day after lambing from ewes with a different number of lambs in the litter for the entire period

During the first 24 hours after lambing, significant differences are observed in the content of fats, lactose, and protein in the colostrum of ewes with a different number of lambs born. For all three indicators, the highest value is recorded in the colostrum of ewes that gave birth to triplets, and the lowest – in ewes with a single lamb.

The largest difference in the percentage of fat content in the colostrum is established between ewes that gave birth to triplets and those with a single lamb – 5.37% ($p < 0.05$).

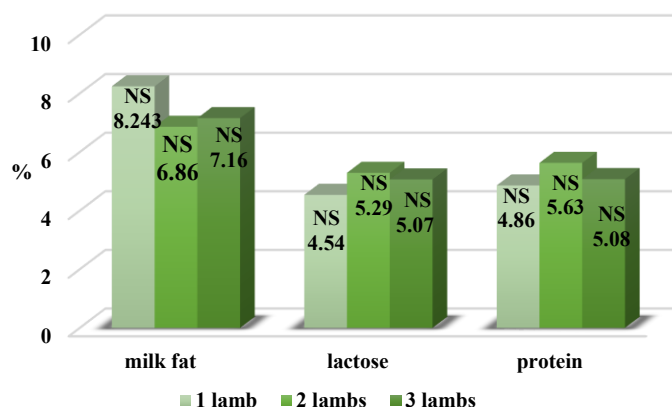
On the second day after lambing, in the colostrum of ewes that gave birth to twins (Fig. 19), we observe higher values for the fat, lactose, and protein indicators ($p > 0.05$) compared to ewes that gave birth to single lambs or triplets.



NS – non-significant

Fig. 19. Colostrum indicators on the 2nd day after lambing from ewes with a different number of lambs in the litter for the entire period

On the 3rd day after lambing, fat content reaches its highest value in the colostrum of ewes with a single lamb. The results for the lactose and protein indicators remain the lowest in ewes with singles, while in mothers that gave birth to twins, they reach their highest values (Fig. 20).



NS – non-significant

Fig. 20. Colostrum indicators on the 3rd day after lambing from ewes with a different number of lambs in the litter for the entire period

In the colostrum of the Romanov sheep breed examined by us, changes similar to those described in other sheep breeds are observed. At the beginning of the colostrum period, the examined indicators show their highest values, which gradually decrease as the days after lambing progress.

2.2. Milk yield and physicochemical analysis of milk from the Romanov sheep breed

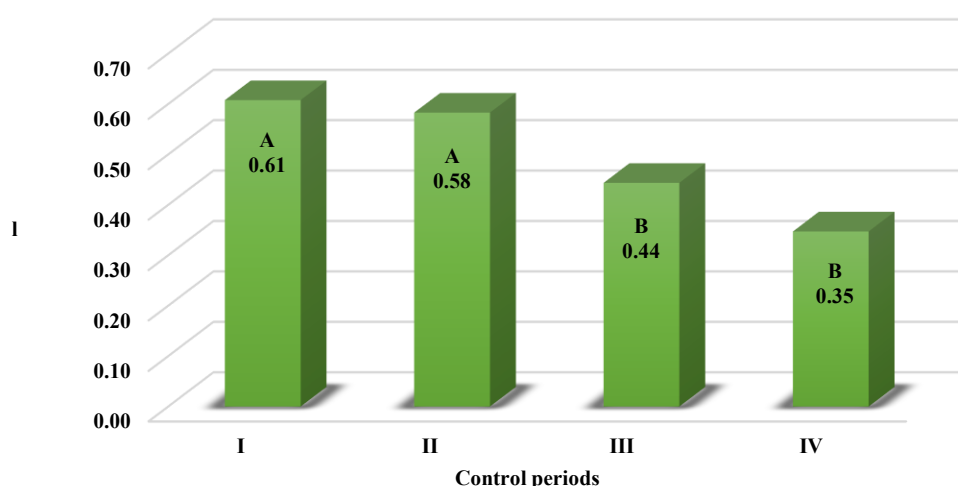
The average daily milk yield varies by control periods and study years (Table 3). The lowest average daily milk yield for all control periods was recorded during the first year of the

study, while the highest was observed for the first control period of the second year and the second and third control periods of the third year.

The average daily milk yield varies by control periods and study years (Table 3). The lowest average daily milk yield for all control periods was recorded during the first year of the study, while the highest was observed for the first control period of the second year and the second and third control periods of the third year.

Table 3. Average daily milk yield by years and by study control periods

Milk yield, l	n	I st year $\bar{x} \pm S\bar{x}$	n	II nd year $\bar{x} \pm S\bar{x}$	n	III rd year $\bar{x} \pm S\bar{x}$
I Control	19	0.62±0.05	12	0.63±0.06	10	0.58±0.08
II Control	36	0.47±0.05	47	0.63±0.05	40	0.65±0.04
III Control	43	0.38±0.03	56	0.46±0.03	35	0.50±0.04
IV Control	33	0.25±0.03	41	0.40±0.03	34	0.40±0.04



Different letters reflect significant differences at $p < 0.001$.

Fig. 21. Average daily milk yield for the entire period

In our study, the average daily milk yield for the entire period is highest during the first control period (Fig. 21). A significant decrease in milk yield is recorded at the 3rd control ($p < 0.001$). During the course of lactation, the milk yield continues to decrease and reaches 0.35 l at the 4th control, with the established difference between the 2nd and 4th control also being statistically significant ($p < 0.001$).

The milk yield by control periods is presented in Table 4.

Table 4. Average milk yield by control periods per lactation for the entire study, l.

Milk yield, l	n	I- ^{ва} контрола $\bar{x} \pm S\bar{x}$	II- ^{ра} контрола $\bar{x} \pm S\bar{x}$	III- ^{та} контрола $\bar{x} \pm S\bar{x}$	IV- ^{та} контрола $\bar{x} \pm S\bar{x}$	Sig.
I year, l	131	18.46 $\pm$ 2.02a	13.98 $\pm$ 1.40ab	11.41 $\pm$ 1.02bc	7.45 $\pm$ 1.02c	***
II year, l	156	18.75 $\pm$ 2.08a	18.78 $\pm$ 1.43a	13.72 $\pm$ 0.79b	11.96 $\pm$ 0.95b	***
III year, l	119	17.52 $\pm$ 2.50ab	19.37 $\pm$ 1.11a	15.02 $\pm$ 1.26abc	12.09 $\pm$ 1.15c	**
Average, l	406	18.23 $\pm$ 1.63a	17.49 $\pm$ 0.82a	13.31 $\pm$ 0.58b	10.42 $\pm$ 0.63b	***

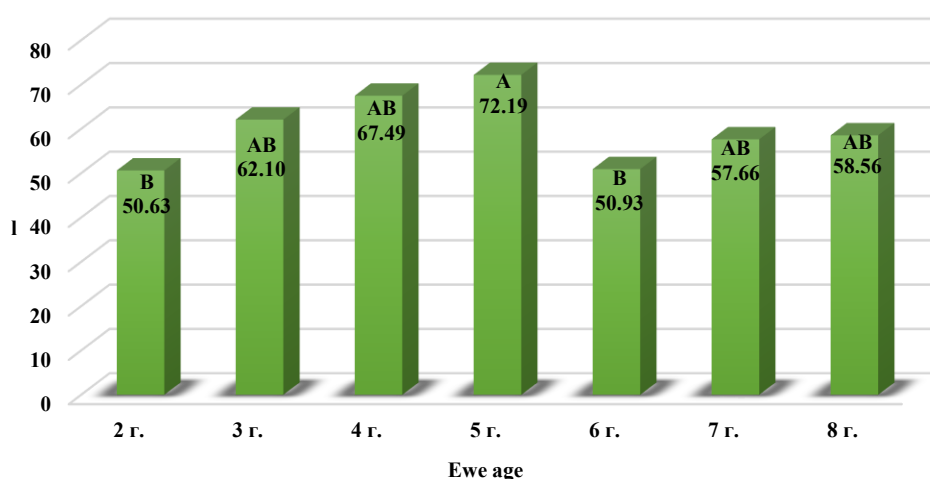
Different letters reflect significant differences; $p < 0.01$; $p < 0.001$

During the first control period, the average milk yield is highest, ranging from 17.52 l in the third year to 18.75 l in the second year. During the course of lactation, the average milk yield for the entire study period gradually decreases, with a significant difference recorded between the first and second control periods on one hand, and the third and fourth control periods on the other ($p < 0.001$).

During the first year of the study, the highest milk yield was recorded at the first control, and it decreased from the second one onwards ($p < 0.001$). During the second and third years of the study, the highest milk yield was recorded at the second control. For the entire study period, an expected decrease in milk yield from the first to the fourth control was observed ($p < 0.001$).

The summarized results for the entire study period show a decrease in milk yield from the first to the fourth control. The highest average values were registered at the first and second controls; they do not differ statistically from each other but are significantly higher compared to the third and fourth controls ($p < 0.001$).

Fluctuations in milk productivity between the individual years of the study can be explained by changes in the age of the ewes in the flock. During the first and second years of the study, younger ewes (aged 2–3 years) predominated in the flock, which had not yet manifested their full productive potential.

Fig. 22. Changes in the average lactation milk yield in ewes of different ages

Different letters reflect significant differences at $p < 0.01$

Fig. 22. Milk yield for 120 days of lactation according to the age of the ewe

The highest lactation milk yield was recorded in five-year-old ewes, with this value significantly exceeding the milk yield of two-year-old ($p < 0.01$) and six-year-old ewes ($p < 0.001$). Similar values of milk productivity were observed in four- and five-year-old sheep, with no clearly defined statistically significant difference established between them. After the fifth year, a sharp decrease in milk yield was recorded in six-year-old sheep, indicating a decline in productivity with advancing age. In sheep at seven and eight years of age, higher values were registered compared to six-year-olds, but the differences did not reach statistical significance.

Figure 23 presents the average lactation milk yield depending on the number of lambs born per lambing.

Based on the number of lambs born during the three-year study period, we found that the highest lactation milk yield was observed in ewes that gave birth to triplets. Their milk yield was higher than that of ewes that gave birth to twins ($p > 0.05$), while the difference compared to ewes with singletons was significantly greater ($p < 0.01$). The lowest milk yield was registered in sheep that gave birth to four lambs ($p < 0.01$) (Fig. 23).



Different letters reflect significant differences at $p < 0.01$

Fig. 23. Milk yield according to the number of offspring per lambing

Table 5 presents the changes in the qualitative composition of the milk by control periods for the individual years, as well as the average values for the entire study period.

Table 5. Qualitative composition of the milk

Indicator	Year of study	I Control	II Control	III Control	IV Control	Sig.
		$\bar{x} \pm S\bar{x}$	$\bar{x} \pm S\bar{x}$	$\bar{x} \pm S\bar{x}$	$\bar{x} \pm S\bar{x}$	
Fat	I st year	5.91±0.55c	7.68±0.27ab	6.99±0.20b	8.12±0.23a	***
	II nd year	6.35±0.35c	6.76±0.22c	7.33±0.20b	7.97±0.21a	***
	III rd year	7.11±0.52	7.17±0.31	7.09±0.37	6.62±0.42	NS
	Average	6.21±0.44b	7.16±0.15a	7.16±0.14a	7.72±0.16a	***
Protein	I st year	5.22±0.50	5.07±0.07	5.12±0.05	5.06±0.05	NS
	II nd year	5.18±0.03	5.02±0.05	4.95±0.03	4.98±0.04	NS
	III rd year	5.05±0.06	5.02±0.06	4.94±0.09	4.87±0.08	NS
	Average	5.18±0.04a	5.04±0.03b	5.01±0.03b	4.99±0.03b	*
Lactose	I st year	4.91±0.05	4.86±0.07	4.86±0.06	4.74±0.06	NS
	II nd year	4.83±0.02	4.72±0.04	4.64±0.03	4.73±0.09	NS
	III rd year	4.73±0.06	4.74±0.06	4.63±0.09 ^b	4.61±0.10	NS
	Average	4.87±0.04	4.76±0.03	4.71±0.03	4.71±0.03	NS
Dry matter	I st year	16.91±0.55c	18.49±0.32a _b	17.82±0.12b	18.76±0.24a _b	***
	II nd year	17.10±0.32b	17.32±0.22b	17.76±0.19b	18.37±0.20a	**
	III rd year	17.74±0.50	17.72±0.30	17.49±0.71	16.91±0.48	NS
	Average	17.10±0.42a	17.80±0.16a _b	17.72±0.12b _c	18.18±0.18c	**
SNF	I st year	10.99±0.11	10.79±0.13	10.83±0.10	10.84±0.10	NS
	II nd year	10.79±0.08	10.56±0.09	10.41±0.60	10.23±0.24	NS
	III rd year	10.62±0.14	10.55±0.12	10.38±0.19	10.33±0.23	NS
	Average	10.90±0.09b	10.63±0.06a	10.55±0.06a _b	10.40±0.12a	*

NS – non-significant; Different letters reflect significant differences; * $p < 0.05$; $p < 0.01$; * $p < 0.001$

Fat content

The fat content indicator (Table 5) is the most variable of all observed parameters. For the entire study period, the lowest value was recorded at the first control, after which it increased at the second control ($p < 0.001$) and remained at constant levels until the end of lactation, with no significant difference observed between controls II, III, and IV.

Protein

During the three years of the study, the values for protein (Table 5) moved within narrow limits, with no significant differences established either between the individual controls or between the individual years of the study. In Romanov sheep, Boylan and Sakul (1988) reported a protein content of 6.1%, which is higher than the average value in our study.

Lactose

Lactose did not show significant fluctuations during the lactation period; a decrease in values was observed as lactation progressed, but without statistical significance ($p > 0.05$).

Dry matter

The dry matter indicator significantly increased from the beginning towards the end of lactation ($p < 0.01$). During the first year of the study, the lowest value of 16.91% was recorded at the first control, and the highest value of 18.76% was recorded at the fourth control ($p < 0.001$).

SNF

The solids-not-fat (SNF) indicator was highest during the first control period, after which it gradually decreased as lactation progressed ($p < 0.05$).

Table 6 presents the average values for titratable acidity, casein, non-casein protein, density, and calcium of the studied milk depending on the control sequence for the entire study period.

From the presented data, it can be concluded that as the days of the lactation period progress, the indicators for casein, non-casein protein, and density gradually decrease. At the same time, titratable acidity increases in the middle of the lactation period and decreases towards its end.

Table 6. Qualitative indicators of the milk, average values by controls

Indicators	I st Control	II nd Control	III rd Control	IV th Control	Sig.
	$\bar{x} \pm S\bar{x}$	$\bar{x} \pm S\bar{x}$	$\bar{x} \pm S\bar{x}$	$\bar{x} \pm S\bar{x}$	
n	3	3	3	3	
Titratable acidity	20.67 $\pm$ 0.33	21.00 $\pm$ 0.58	22 $\pm$ 0.00	21.00 $\pm$ 1.00	NS
Casein (%)	3.47 $\pm$ 0.66	2.78 $\pm$ 0.14	2.63 $\pm$ 0.14	2.67 $\pm$ 0.07	NS
NCP (%)	2.27 $\pm$ 0.14	2.20 $\pm$ 0.40	2.16 $\pm$ 0.28	2.24 $\pm$ 0.11	NS
Density (g/cm³)	1.0374 $\pm$ 0.00	1.0342 $\pm$ 0.00	1.0336 $\pm$ 0.00	1.0341 $\pm$ 0.00	NS
Ca (mg/%)	0.23 $\pm$ 0.01	0.22 $\pm$ 0.02	0.19 $\pm$ 0.02	0.20 $\pm$ 0.01	NS

NS – non-significant

3. Establishment of fattening abilities and meat qualities of male and female lambs

3.1. Growth rate of lambs and fodder conversion

The data in Table 7 reflect the live weight gain for a 60-day fattening period of male and female triplet lambs.

During the fattening period, the male lambs increased their live weight by 17.87 kg, while in the female lambs, the increase was 12.83 kg ($p < 0.05$). Correspondingly, the average daily gain was also higher in the group of male lambs, which gained 0.09 kg/day more than the females ($p < 0.01$) (Table 7).

Table 7. Absolute and average daily gain, (kg)

Group	Male $\bar{x} \pm S\bar{x}$	Female $\bar{x} \pm S\bar{x}$	Sig.
n	6	6	
Live weight at the beginning of the experiment, kg	15.55 $\pm$ 0.8	14.32 $\pm$ 0.58	NS
Live weight at the end of the experiment, kg	33.41 $\pm$ 1.62	27.15 $\pm$ 1.21	*
Absolute gain, kg	17.87 $\pm$ 1.02	12.83 $\pm$ 0.85	**
Average daily gain, g/day	0.30 $\pm$ 0.02	0.21 $\pm$ 0.01	**

Analyzing the data presented in Table 7, we can conclude that the male lambs have a higher growth intensity than the females.

Table 8 presents the fodder conversion per 1 kg of gain for the male and female triplets.

Table 8. Fodder conversion per 1 kg of gain in male and female triplets

Sex	n	Fodder consumption per 1 kg of gain		FUG	IDP
		Concentrated fodder, kg	Bulky fodder, kg		
Male	6	4.26	0.67	5.64	483.33
Female	6	4.91	1.17	6.70	579.35

For the realization of 1 kg of gain, female lambs require 0.65 kg more **concentrated fodder** and 0.50 kg more hay compared to male lambs.

3.2. Slaughter analysis – pre-slaughter live weight, carcass weight and internal organs, slaughter yield, and cooling losses

The results obtained from linear measurements performed on the cooled left half of the carcasses are presented in Table 9.

Table 9. Linear carcass parameters, cm

Indicator, (cm)	Male $\bar{x} \pm S\bar{x}$	Female $\bar{x} \pm S\bar{x}$	Sig.
n	3	3	
Carcass length	54.67 $\pm$ 0.33	48.67 $\pm$ 2.03	*
Leg length	49.67 $\pm$ 0.33	48.00 $\pm$ 0.00	**
Chest width	24.00 $\pm$ 1.00	20.33 $\pm$ 0.88	*

* $p < 0.05$; ** $p < 0.01$

In male and female lambs, the following parameters were recorded: carcass length ($p < 0.05$), leg length ($p < 0.01$), and chest width ($p < 0.05$) (Table 9). The values obtained for all linear measurements are significantly higher in male lambs compared to females.

Table 10 presents the slaughter characteristics: live weight before slaughter, hot and cold carcass weight, as well as the calculated slaughter yield.

The pre-slaughter live weight is 6.93 kg higher in male lambs than in females ($p < 0.001$). The weights of the hot and chilled carcass in male lambs show significantly higher values compared to those in females ($p < 0.05$).

Table 10. Slaughter characteristics of the carcass of male and female lambs

Group	Male $\bar{x} \pm S\bar{x}$	Female $\bar{x} \pm S\bar{x}$	Sig.
n	3	3	
Live weight before slaughter, kg	32.79 $\pm$ 0.51	25.86 $\pm$ 0.51	***
Hot carcass, kg	15.80 $\pm$ 0.67	12.94 $\pm$ 0.19	*
Cooling losses, kg	0.32 $\pm$ 0.03	0.33 $\pm$ 0.02	NS
Cold carcass, kg	15.48 $\pm$ 0.69	12.6 $\pm$ 0.19	*
Slaughter yield, %	47.17 $\pm$ 1.41	48.75 $\pm$ 0.29	NS
Meat-to-bone ratio	3.36 $\pm$ 0.22	3.69 $\pm$ 0.11	NS

Ns – non-significant; * $p < 0.05$; *** $p < 0.001$

Regarding the slaughter yield, the values recorded for female lambs were 1.58% higher than those for males ($p > 0.05$). Cooling losses were also higher in female lambs compared to males ($p > 0.05$).

The meat-to-bone ratio (fleshing index) in male lambs was 3.36:1, while in females it was 3.69:1, with the difference favoring the females ($p > 0.05$).

Table 11 presents the carcass composition of male and female Romanov lambs. The carcasses were dissected into six cuts: neck, shoulder, loin, leg, chest, and flank. The data were obtained after deboning all cuts from the left half-carcass of the fattened slaughter animals.

The leg had the highest weight of all cuts, accounting for the largest share of the left half-carcass weight. This cut was significantly heavier in male lambs compared to females. Accordingly, the amount of bone ($p < 0.01$) and muscle ($p < 0.05$) was greater in the male animals.

The weight of the chest ranged between 2.04 kg and 1.57 kg for male and female lambs, respectively. Muscles averaged 43.8% of the weight of this part in both groups. The chest is the cut containing the highest amount of bone tissue compared to the other parts of the carcass. This is due to the skeletal structure of this region. In male lambs, the weight of the chest bones was higher compared to that in females ($p < 0.001$).

Table 11. Carcass composition of male and female Romanov lambs, kg

Group	Male	Female	Sig.
	$\bar{x} \pm S\bar{x}$	$\bar{x} \pm S\bar{x}$	
Left half-carcass	8.05±0.10	6.29±0.08	*
Neck	1.02±0.06	0.69±0.01	**
Bones	0.24±0.01	0.15±0.006	***
Muscles	0.51±0.057	0.33±0.03	*
Fat	0.27±0.002	0.22±0.02	NS
Shoulder	1.25±0.03	1.03±0.02	**
Bones	0.27±0.002	0.22±0.01	***
Muscles	0.87±0.02	0.70±0.01	***
Fat	0.11±0.01	0.12±0.02	NS
Loin	0.86±0.14	0.62±0.04	NS
Bones	0.24±0.06	0.16±0.03	NS
Muscles	0.46±0.07	0.33±0.01	NS
Fat	0.17±0.01	0.14±0.01	NS
Leg	2.22±0.06	1.80±0.07	**
Bones	0.43±0.002	0.34±0.01	**
Muscles	1.33±0.02	1.12±0.06	*
Fat	0.32±0.04	0.23±0.02	NS
Chest	2.04±0.07	1.57±0.04	**
Bones	0.59±0.01	0.43±0.02	***
Muscles	0.89±0.07	0.69±0.07	NS
Fat	0.42±0.02	0.37±0.08	NS
Flank	0.62±0.07	0.54±0.02	NS
Muscles	0.32±0.04	0.24±0.02	NS
Fat	0.30±0.06	0.30±0.04	NS

NS – non-significant; * $p < 0.05$; $p < 0.01$; *** $p < 0.001$

The weight of the shoulder differs significantly between male and female lambs, with this cut being heavier in males ($p < 0.01$). The bone and muscle tissue in the shoulder are also significantly higher in male lambs ($p < 0.001$).

The flank has the lowest weight in both groups and consists only of muscles and fat. The muscle tissue in males is 0.08 kg more than in females ($p > 0.05$), while the amount of fat is identical in both groups.

The measurements and subsequent analysis indicate that fattened Romanov lambs exhibit high dressing percentage and good meat productivity.

The weights of the internal organs and certain carcass parts, such as the head, skin, and feet, were also recorded. The resulting data are presented in Table 12.

Table 12. Internal organs

Indicator, kg		Male $\bar{x} \pm S\bar{x}$	Female $\bar{x} \pm S\bar{x}$	Sig.
n		3	3	
Heart		0.13±0.01	0.11±0.01	NS
Lungs		0.51±0.06	0.36±0.03	NS
Liver		0.62±0.04	0.48±0.02	*
Spleen		0.06±0.00	0.05±0.00	*
Kidneys		0.09±0.00	0.08±0.00	**
Stomach – empty		0.85±0.05	0.64±0.06	*
Intestines – empty	Small intestines	0.69±0.03	0.62±0.01	*
	Large intestines	0.88±0.03	0.78±0.02	*
Testicles		0.41±0.04	-	-
Fat	Kidney fat	0.14±0.05	0.19±0.01	NS
	Pelvic cavity	0.14±0.01	0.09±0.01	*
Head		1.31±0.03	1.06±0.01	***
Skin		4.07±0.18	3.09±0.27	**
Feet (4 pcs.)		0.87±0.01	0.72±0.03	*

NS – non-significant; * $p < 0.05$; $p < 0.01$; *** $p < 0.001$

It was found that the heart weight in male lambs was higher than in females by 18.19%, although this difference was not statistically significant ($p > 0.05$). In male lambs, the weights of the liver ($p < 0.05$), kidneys ($p < 0.01$), stomach ($p < 0.05$), and both small and large intestines were significantly higher compared to female lambs (Table 12).

No significant differences were observed between the two sexes regarding the weights of the heart, lungs, and perirenal fat.

The amount of pelvic fat in male lambs was, on average, 55.56% higher than in females ($p < 0.05$).

The differences in the weight of the head, skin, and feet were also in favor of the male lambs. For all these analyzed parameters, statistically significant differences of varying degrees were observed between the two study groups.

3.3. Technological qualities and chemical composition of the meat

The technological qualities (pH, tenderness, color, and water-holding capacity) of the two examined muscles are presented in Table 13.

The pH values at 45 minutes for *m. Longissimus thoracis et lumborum* ranged from 6.37 to 6.45, while for *m. Semimembranosus*, they ranged from 6.09 to 6.19, as established for male and female lambs respectively ($p > 0.05$). No significant differences were observed for this parameter. Data from both experimental groups for pH₄₅ were higher in *m. Longissimus thoracis et lumborum* compared to *m. Semimembranosus* ($p > 0.05$).

At the 24-hour measurement, the pH₄₅ decreased in both groups of lambs and in both examined muscles. Significantly higher values for this parameter were recorded in the group of male lambs for both muscles ($p < 0.05$). The pH values recorded 24 hours post mortem for *m. Longissimus thoracis et lumborum* in both male and female lambs were lower than those recorded for *m. Semimembranosus*.

Table 13. pH, tenderness, color, and water-holding capacity of meat from male and female Romanov lambs

Indicator			Male	Female	Sig.
			$\bar{x} \pm S\bar{x}$	$\bar{x} \pm S\bar{x}$	
n			3	3	
pH 45 min. m. LTL			6.37±0.10	6.45±0.13	NS
pH 45 min. m. S.M.			6.09±0.07	6.19±0.08	NS
pH 24 h m. LTL			5.75±0.01	5.60±0.04	*
pH 24 h m. S.M.			5.77±0.03	5.61±0.03	*
Tenderness (P°)		<i>m. LTL</i>	149.33±0.35	148.9±1.78	NS
		<i>m. S. M.</i>	141.93±4.88	149.57±0.73	NS
WHC%		<i>m. LTL</i>	33.26±1.25	33.20±1.31	NS
		<i>m. S. M.</i>	35.26±1.63	35.64±9.79	NS
Color	<i>m. LTL</i>	<i>L</i> *	39.02±0.04	39.49±1.30	NS
		<i>a</i> *	13.54±0.15	14.68±0.18	NS
		<i>b</i> *	9.96±0.30	10.26±0.64	NS
	<i>m. S. M</i>	<i>L</i> *	38.22±0.18	38.43±1.17	NS
		<i>a</i> *	15.02±0.18	13.7±0.81	NS
		<i>b</i> *	8.94±0.21	9.46±0.07	NS

NS – non-significant; * $p < 0.05$

The **tenderness** of *m. Longissimus thoracis et lumborum* in male lambs was 0.3% higher than that recorded for the same muscle in female lambs ($p > 0.05$), while for *m. Semimembranosus*, the difference between the two groups was 5.4% in favor of the female lambs ($p > 0.05$).

The highest values for **water-holding capacity** (WHC) were established in *m. Semimembranosus* of the female lambs, while the lowest values were observed in *m. Longissimus thoracis et lumborum*, also within the female group.

In the group of male lambs, *m. Semimembranosus* showed a higher value for this parameter compared to *m. Longissimus thoracis et lumborum* ($p > 0.05$). In the female lambs, the difference between the two muscles was mathematically proven ($p < 0.05$). This indicates that *m. Longissimus thoracis et lumborum* in both sexes possesses a better water-holding capacity than that of *m. Semimembranosus*.

The established values for the **lightness** (L)* of the meat color in both study groups were similar for both *m. Longissimus thoracis et lumborum* and *m. Semimembranosus*.

Regarding the redness (a*) of the meat, a higher value was established in *m. Longissimus thoracis et lumborum* for the female lambs, while for *m. Semimembranosus*, the a coordinate* was higher in the male lambs. Within the male group, the value of this parameter was higher in *m. Semimembranosus*, whereas in the female group, higher values were recorded for *m. Longissimus thoracis et lumborum*. Despite the observed variations, no statistically significant differences were found between the individual experimental groups ($p > 0.05$).

The values obtained for yellowness (b*) were higher in the female lambs for both *m. Longissimus thoracis et lumborum* and *m. Semimembranosus* ($p > 0.05$). In both study groups, higher values for the b parameter* were recorded in *m. Longissimus thoracis et lumborum* compared to *m. Semimembranosus* ($p > 0.05$).

Table 14 presents the obtained values for the chemical parameters – protein, fat, and mineral substances (ash) – in *m. Longissimus thoracis et lumborum* and *m. Semimembranosus* of the experimental animal groups.

Table 14. Chemical composition of meat from male and female Romanov lambs

Muscle	Indicator	Male $\bar{x} \pm S\bar{x}$	Female $\bar{x} \pm S\bar{x}$	Sig.
<i>m. LTL</i>	Moisture, %	74.89±0.22	74.95±0.37	NS
	Protein %	23.25±0.69	21.20±0.54	NS
	Fat %	2.32±0.18	2.09±0.62	NS
	Ash %	1.23±0.02	1.28±0.02	NS
<i>m. S.M.</i>	Moisture %	74.99±0.31	75.10±0.36	NS
	Protein %	22.03±0.31	21.15±0.80	NS
	Fat %	2.23±0.19	1.97±0.29	NS
	Ash %	1.44±0.09	1.19±0.01	*

NS – non-significant; * $p < 0.05$

Moisture:

The moisture content in the two examined muscles varied within narrow limits. No significant differences were found either between the two muscles or between the two sexes.

Protein:

This parameter showed higher values in the group of male lambs. The value established for *m. Longissimus thoracis et lumborum* in male lambs was higher than that in females ($p > 0.05$). For *m. Semimembranosus*, the difference between the two sexes was negligible ($p > 0.05$).

Fat:

The chemical analysis of the meat from male and female Romanov lambs showed that the fat content was higher in both examined muscles of the male lambs compared to the females ($p > 0.05$). No significant differences in fat content were observed between the two muscles.

Ash:

In the study of the two muscles, we found that the ash content in *m. Longissimus thoracis et lumborum* reached a higher value in female lambs compared to males ($p > 0.05$). Conversely, for *m. Semimembranosus*, the value in the male lamb group was significantly higher than in the females ($p < 0.05$).

Depending on the muscle examined, the ash content varied from 1.19 to 1.62% in male lambs and from 1.18 to 1.29% in female lambs. A significant difference between *m. Longissimus thoracis et lumborum* and *m. Semimembranosus* was calculated within the group of female lambs ($p < 0.05$).

The data regarding the chemical composition and technological qualities of meat from Romanov lambs are comparable to those available in the literature and contribute to the scientific information regarding the meat quality of this breed.

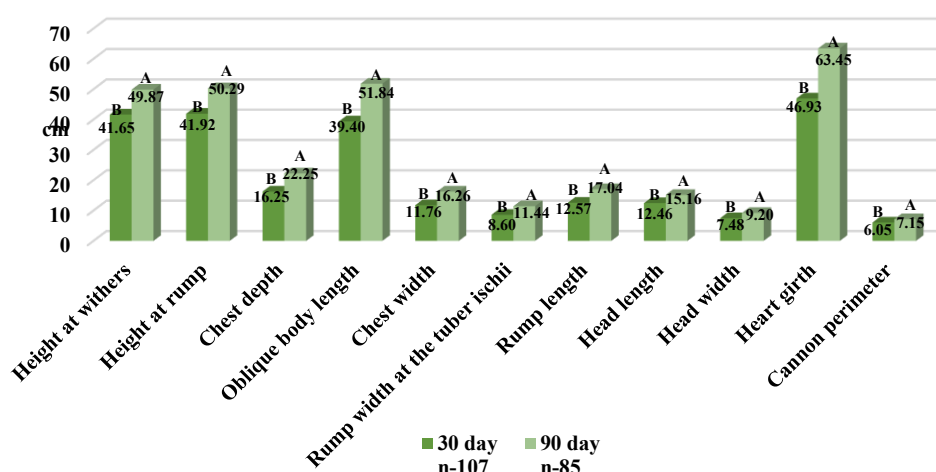
4. Exterior measurements of animals at different ages

Figure 24 presents data regarding the exterior measurements of Romanov lambs at 30 and 90 days of age.

The height of the animals is expressed through two exterior measurements: height at withers and height at rump. **The height at withers** in Romanov lambs varies from 41.65 ± 0.29 cm (at 30 days) to 49.87 ± 0.44 cm (at 90 days of age). The values for **height at rump** are also lowest at 30 days of age (41.92 ± 0.29 cm) and highest at 90 days (50.29 ± 0.45 cm).

The oblique body length varies from 39.40 ± 0.38 cm (at 30 days) to 51.84 ± 0.65 cm (at 90 days of age).

The values for **rump length and rump width (at the tuber ischii)** are significantly higher in Romanov lambs at 90 days of age – 17.04 ± 0.24 cm and 11.44 ± 0.20 cm, respectively—compared to those at 30 days: 12.57 ± 0.14 cm and 8.60 ± 0.13 cm ($p < 0.001$). Compared to the previous period, the values for rump length increased by 35.5%, and the rump width at the tuber ischii increased by 32.9%.



Different letters indicate significant differences at $p < 0.001$.

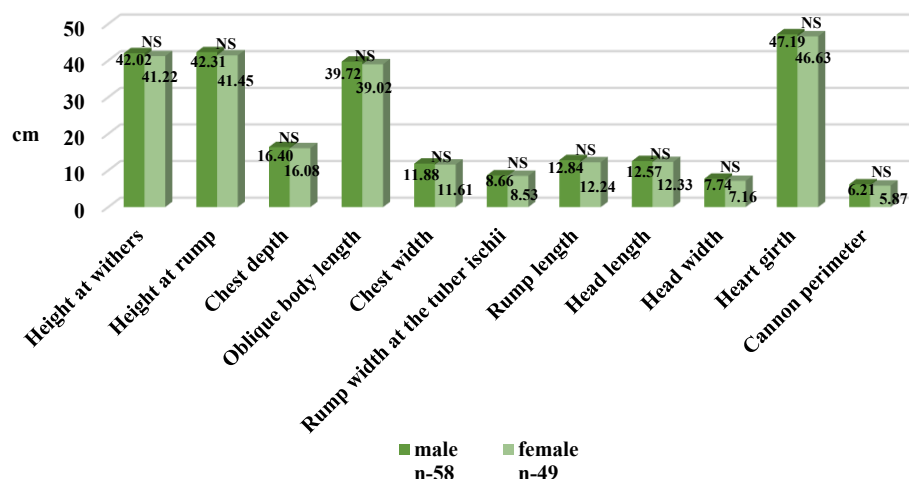
Fig. 24. Exterior measurements of lambs at 30 and 90 days of age for the entire study

For **chest width** and **chest depth**, the differences between the mean values of the individual age groups are 4.48 cm and 6.00 cm, respectively, in favor of the animals at 90 days of age. Regarding heart girth (**chest circumference**), this difference is even greater – 16.52 cm. The values for chest depth and width significantly increase at 90 days compared to 30 days of age, with differences of 36.86% and 38.30% ($p < 0.001$).

The mean values for **cannon perimeter** in the different age groups vary from 6.05 ± 0.06 cm (at 30 days) to 7.15 ± 0.07 cm (at 90 days).

The **head length** and **head width** of the studied animals between the different ages vary from 12.46 ± 0.12 cm and 7.48 ± 0.09 cm (at 30 days) to 15.16 ± 0.15 cm and 9.20 ± 0.10 cm (at 90 days).

Figure 25 presents the data for exterior measurements at 30 days of age in male and female Romanov lambs for the entire study period.



NS – non-significant

Fig. 25. Exterior measurements of male and female lambs at 30 days of age for the entire study

In male lambs at 30 days of age, the mean **height at withers** and **height at rump** were 42.02 ± 0.39 cm and 42.31 ± 0.40 cm, respectively, while in females, the values were 41.22 ± 0.42 cm and 41.45 ± 0.41 cm.

The **oblique body length** in animals at 30 days of age varied from 39.02 ± 0.63 cm (in females) to 39.72 ± 0.45 cm (in males).

The difference between the mean values of male and female animals for **rump length** and **rump width (at the tuber ischii)** was small—0.6 cm and 0.13 cm, respectively.

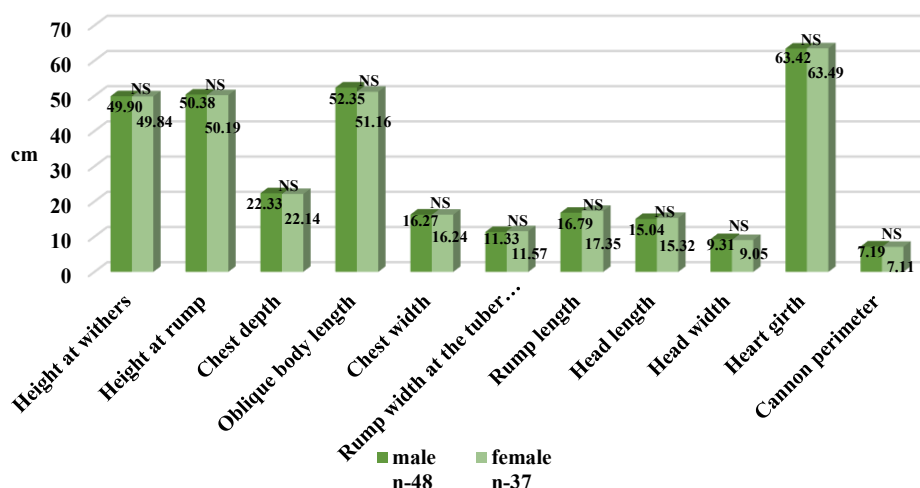
The **chest width, depth, and heart girth** in male lambs were 11.88 ± 0.21 cm, 16.40 ± 0.24 cm, and 47.19 ± 0.47 cm, respectively, while in females, the values for the same measurements were as follows: 11.61 ± 0.22 cm, 16.08 ± 0.22 cm, and 46.63 ± 0.41 cm.

The results for **cannon perimeter** were similar in value, favoring the male lambs, with an average of 6.21 ± 0.09 cm in male Romanov lambs and 5.87 ± 0.09 cm in females. Tsochev et al. (2018) reported lower values for **cannon perimeter** than those obtained in our study for both sexes.

The mean **head length** and **head width** in male Romanov lambs at 30 days of age were 12.57 ± 0.17 cm and 7.74 ± 0.13 cm, while in females of the same age, the values were 12.33 ± 0.16 cm and 7.16 ± 0.10 cm.

Data regarding the exterior measurements of male and female lambs at **90 days of age** are presented in Figure 26.

In male lambs at 90 days of age, the mean **height at withers** and **height at rump** were 49.90 ± 0.66 cm and 50.38 ± 0.66 cm, respectively, while in females, the values were 49.84 ± 0.56 cm and 50.19 ± 0.53 cm (Fig. 26).



NS – non-significant

Fig. 26. Exterior measurements of male and female lambs at 90 days of age for the entire study

In animals at 90 days of age, the **oblique body length** varied from 51.16 ± 0.80 cm (females) to 52.35 ± 0.98 cm (males).

The **rump length** and **rump width** (at the tuber ischii) were 17.35 ± 0.34 cm and 11.57 ± 0.32 cm in females, and 16.79 ± 0.34 cm and 11.33 ± 0.27 cm in males, respectively.

The **chest width**, **chest depth**, and **heart girth** in male lambs were 16.27 ± 0.30 cm, 22.33 ± 0.30 cm, and 63.42 ± 0.81 cm, respectively, while in females, the values for the same measurements were as follows: 16.24 ± 0.37 cm, 22.14 ± 0.40 cm, and 63.49 ± 1.00 cm.

The **cannon perimeter** averaged 7.19 ± 0.11 cm in male Romanov lambs and 7.11 ± 0.08 cm in females.

The mean **head length** and **head width** in male Romanov lambs at 90 days of age were 15.04 ± 0.22 cm and 9.31 ± 0.15 cm, while in females of the same age, the values were 15.32 ± 0.17 cm and 9.05 ± 0.14 cm.

Table 15 presents the data for exterior measurements in female animals at 9, 18 months, and 2.5 years of age.

The change in the values for **height at withers** and **height at rump** in female animals between 9 and 18 months was 1.52 cm ($p < 0.001$) and 1.37 cm ($p > 0.05$), respectively. At the subsequent measurement at 2.5 years of age, the values increased by 2.31 cm ($p < 0.001$) and 1.96 cm ($p > 0.05$).

The values for **oblique body length** increased by 11% ($p < 0.001$) between 9 and 18 months, while the difference between 18 months and 2.5 years was 0.3% ($p > 0.05$).

The mean values for **rump length** remained within very narrow limits across the different age groups of ewes, ranging from 22.77 ± 0.42 cm in animals at 9 months to 23.77 ± 0.28 cm at 2.5 years of age. The values for **rump width at the tuber ischii** increased by 15.60% ($p < 0.001$) between 9 and 18 months, while the difference between 18 months and 2.5 years was 6.73%.

Table 15. Exterior measurements of female animals at 9, 18 months, and 2.5 years of age

Exterior measurements, cm	Female, $\bar{x} \pm S\bar{x}$			
n	31	22	9	Sig.
Age	9 м.	18 м.	2.5 г.	
Height at withers	61.48±0.66a	63.00±0.83b	65.31±0.36c	***
Height at rump	62.29±0.51b	63.66±1.04ab	65.62±0.40a	**
Chest depth	29.90±0.71c	32.00±0.47b	32.77±0.55a	**
Oblique body length	65.39±1.23b	72.55±1.22a	72.77±1.56a	***
Chest width	22.87±0.43	23.44±0.80	23.92±0.49	NS
Rump width at the tuber ischii	15.84±0.45b	18.31±0.31a	19.55±0.58a	***
Rump length	22.77±0.42	23.77±0.32	23.77±0.28	NS
Head length	19.03±0.28b	20.23±0.41ab	20.88±0.35a	**
Head width	10.39±0.13b	11.00±0.16a	11.00±0.16a	*
Heart girth	87.39±1.17b	90.69±1.19ab	92.89±1.43a	*
Cannon perimeter	7.42±0.13	7.62±0.18	7.67±0.17	NS

NS – non-significant

Different letters indicate significant differences at * $p < 0.05$; $p < 0.01$; *** $p < 0.001$

The variation in **chest width** values between 9 months and 2.5 years of age is insignificant, ranging from 22.87 cm to 23.90 cm. The difference between 9 and 18 months for **chest depth** and **heart girth** is 2.1 cm and 3.3 cm, respectively, while between 18 months and 2.5 years, the difference is **0.77 cm** and **2.2 cm**. The findings in our study are higher than those reported by Tsochev et al. (2018).

The **cannon perimeter** averaged 7 cm at 9 months, 18 months, and 2.5 years of age.

Between 9 and 18 months, the values for **head length** and **head width** increased by 4.39% and 6.31%, while between 18 months and 2.5 years, the difference was 3.2%.

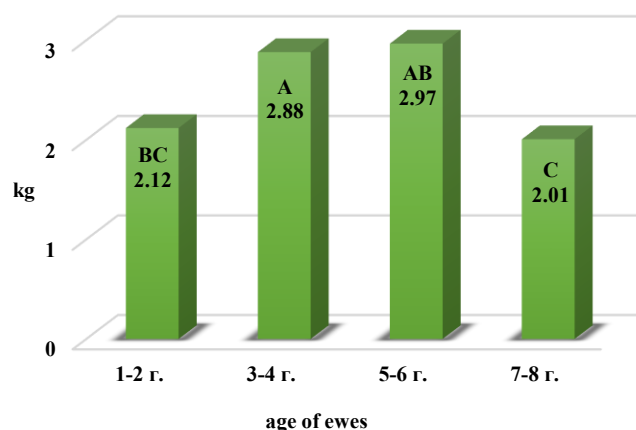
The results for exterior measurements obtained in our study show an increase with age, which corresponds to the findings of other authors. The mean values of the exterior measurements of the lambs at 90 days of age are significantly higher compared to those at 30 days of age ($p < 0.001$). At both thirty and ninety days of age, male Romanov lambs outperform females in all exterior measurements, although the differences are small and not statistically significant ($p > 0.05$).

In the exterior measurements of female animals between 9 months and 2.5 years of age, an increase in mean values with age is observed, with this change being most pronounced in **oblique body length** and **heart girth**.

5. Wool yield and wool fineness

Romanov lambs are born with a deep black coat featuring clearly defined white patches on the forehead. Some individuals also exhibit white spots on the lower parts of the limbs and the tip of the tail. The black color is maintained until approximately two to three months of age, after which the wool turns gray due to the growth of down fibers.

Figure 27 presents the average wool yield of the studied Romanov ewes, according to the age of the ewes.



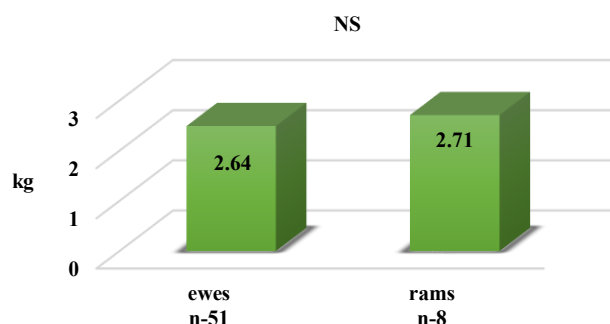
Different letters indicate significant differences at $p < 0.05$

Fig. 27. Wool yield from ewes

In 1-2-year-old sheep, the wool yield is lower in comparison to the animals that have completed their growth ($p < 0.05$).

The values of the studied parameter are highest in ewes at the age between 3 and 6 years, after which in the 7-8-year-olds they decrease, as the difference is mathematically proven ($p < 0.05$).

The wool yield in rams is higher by 2.65% compared to that in ewes, with a difference of 2.65% ($p > 0.05$) (Fig. 28).



NS – non-significant

Fig. 28. Average wool yield in ewes and rams

In the analysis of the data from Table 16, it is evident that there is no clearly expressed dependency between the age of the ewes and the fiber thickness.

The thinnest down fibers in the shoulder area were recorded in seven-year-old ewes ($10.48 \pm 0.39 \mu\text{m}$), while the thickest ones from the same area were found in six-year-old animals ($11.4 \pm 0.45 \mu\text{m}$).

In the thigh area, the down fibers with the greatest thickness were found in ewes at six years of age, while the thinnest were in seven-year-old ewes.

Regarding the kemp fibers (outercoat fibers) in the shoulder area, the largest diameter was recorded in animals at seven years of age ($35.78 \pm 2.12 \mu\text{m}$), whereas the ewes at four years of age had the thinnest kemp fibers in the area.

Table 16. Wool fineness depending on the age of the ewes

Age	n	Down fibers – shoulder	Down fibers – thigh	Kemp fibers – shoulder	Kemp fibers – thigh	Sig.
		μm	μm	μm	μm	
		$\bar{x} \pm S\bar{x}$	$\bar{x} \pm S\bar{x}$	$\bar{x} \pm S\bar{x}$	$\bar{x} \pm S\bar{x}$	
3	10	11.21 ± 0.25	11.82 ± 0.30	35.03 ± 2.61	47.23 ± 2.96	NS
4	10	10.88 ± 0.36	11.61 ± 0.30	33.11 ± 2.08	48.46 ± 3.89	NS
6	12	11.40 ± 0.45	11.85 ± 0.33	34.40 ± 3.63	43.28 ± 4.35	NS
7	10	10.48 ± 0.39	11.56 ± 0.56	35.78 ± 2.12	37.53 ± 2.76	NS

NS – non-significant

In four-year-old ewes, the thickest kemp fibers in the thigh area were also recorded ($48.46 \pm 3.89 \mu\text{m}$), while the thinnest were found in ewes at seven years of age.

The average thickness of the down fibers of the studied flock of the breed is $11.35 \pm 0.14 \mu\text{m}$, and that of the kemp fibers is $39.33 \pm 1.26 \mu\text{m}$ ($p < 0.001$).

Table 17 presents the mean values for the fiber thickness in the different topographical areas in the studied ewes.

Table 17. Wool fineness, μm

	n	Shoulder	Thigh	Mean	Sig
$\bar{x} \pm S\bar{x}$	42	23.07 ± 1.48	28.29 ± 2.04	25.68 ± 1.27	*

* $p < 0.05$

From the data in the table, it is evident that the fibers in the shoulder area are thinner compared to those in the thigh area, as the difference is mathematically proven ($p < 0.05$).

Higher values than those obtained by us for the thickness of down and kemp fibers are established by Krivopushkin et al. (2021) – $21.00 \pm 0.08 \mu\text{m}$ and $56 \pm 1.86 \mu\text{m}$, as the cited study also reports the presence of heterotype fibers in purebred Romanov sheep.

In a comparative study, Lupton et al. (2004) evaluate the influence of different sire breeds (Dorset, Romanov, Texel, and Montadale) with a dam breed of Northwestern White-face sheep on the wool characteristics in F1 ewes. The authors find that the crosses with Romanov sires have the thinnest fibers ($24.9 \mu\text{m}$), while the sheep with Texel sires are characterized by the coarsest fibers ($28.7 \mu\text{m}$). The average fiber thickness obtained by them in Romanov crosses is close to our results, as the value in the current study is higher by $0.78 \mu\text{m}$.

The wool of the sheep of the Romanov breed is coarse, non-uniform, with the presence of two types of fibers – down and kemp.

During the shearing of the animals, the individual wool quantity was measured. The average wool yield in ewes is 2.64 kg , and in rams – 2.71 kg .

The quantity of greasy wool at 3-4 years of age (2.88 kg) significantly exceeds this indicator in 1-2 year olds (2.12 kg) and 7-8 year old ewes (2.01 kg) ($P < 0.05$). The average thickness of the down fibers of the Romanov sheep from the studied flock is $11.35 \pm 0.14 \mu\text{m}$, and that of the kemp fibers is $39.33 \pm 1.26 \mu\text{m}$ ($p < 0.001$).

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6. Reproductive performance of Romanov sheep breed

Figure 29 presents the main reproductive indicators of the Romanov sheep – conception rate, biological fecundity, and economic fecundity.

Throughout the three years of the study, the conception rate in the investigated Romanov flock averaged 87.64%. The lowest value was recorded during the first year of the study, while the highest was in the second year. The average biological fecundity of the ewes of this breed is 236.28%, which corresponds to 2.36 lambs per ewe per lambing.

When analyzing the results by year, the highest average value was recorded in the third year of the study, and the lowest in the second year. The difference between the two years is 22.53%. The economic fecundity averages 177.55%, with the results obtained for this reproductive indicator being similar across the individual years.

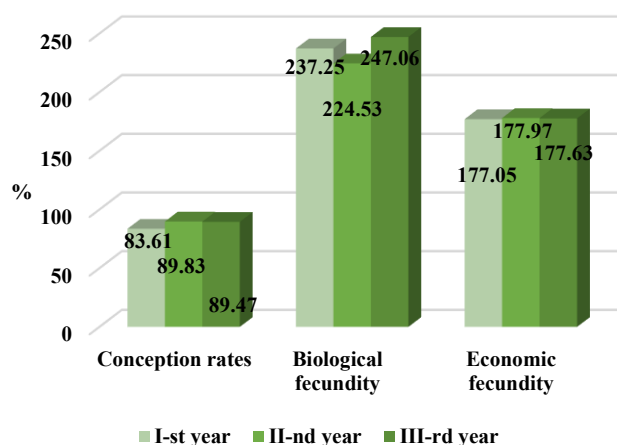


Fig. 29. Reproductive indicators by years

The differences in results between individual studies can be explained by the influence of nutrition, the health status of the ewes, and the breeding method used on the conception rate.

The fecundity of ewes depends on the breed, age, the timing of the breeding season and the onset of estrus, as well as the conditions of nutrition and rearing.

Figure 30 and Table 18 reflect the percentage ratio of ewes with different types of birth and their distribution by the years of the study.

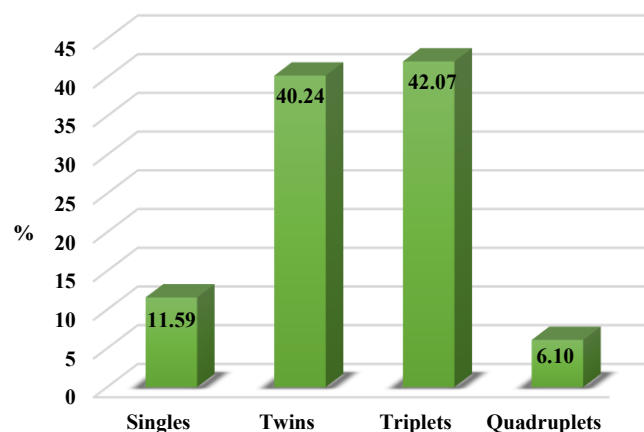


Fig. 30. Percentage ratio of ewes by type of birth for the entire study

In the flock we studied, we found that the highest percentage was for ewes giving birth to triplets (42.07%) (Fig. 30), varying across the individual years from 33.40% in the first year to 48.40% in the third year of the study (Table 18). On average for all years, the share of dams that gave birth to twins is 40.24% (Fig. 30). The percentage of ewes with twins was highest in the first year of the study (49.00%) and lowest in the second year (35.30%) (Table 18). The smallest share in the flock consisted of ewes giving birth to singles (11.59%) and quadruplets (6.10%) per lambing, and in the second year of the study, only 2.00% of the ewes gave birth to quadruplets.

Table 18. Percentage ratio of ewes by type of birth and years

Ewes by type of birth, %					
Year	n	Singles	Twins	Triplets	Quadruplets
I st year	51	9.80	49.00	33.40	7.80
II nd year	53	19.60	35.30	43.10	2.00
III rd year	68	6.50	37.00	48.40	8.10

The distribution of lambs according to their type of birth is presented by years in Figure 31.

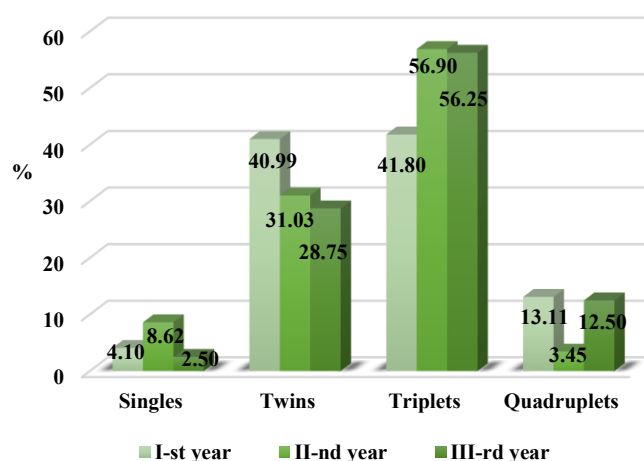


Fig. 31. Distribution of born lambs according to the type of birth, %

On average for the study period, 4.77% of the born lambs are singles, 33.18% are twins, 52.00% are triplets, and 10.05% are quadruplets.

In conclusion, we can summarize:

The study we conducted provides an up-to-date look at the phenotypic and genotypic parameters of Romanov sheep reared under the modern conditions of Bulgaria, and specifically the Fore-Balkan region, in one of the first farms where the breed was imported in 1974 – 1975.

The dynamics of the live weight of lambs up to 90 days of age, the weight of female animals up to 2.5 years of age, as well as their weight gain, have been established. Exterior measurements were performed on animals of various ages from 30 days to 2.5 years. Milk productivity and milk composition were studied, and for the first time, data on the physicochemical composition of colostrum from the Romanov sheep breed in Bulgaria are provided.

The analysis of colostrum and milk of the Romanov sheep shows a clearly expressed dynamics in their composition during the early postnatal and lactation periods. The differences in composition, depending on the number of lambs born, demonstrate the adaptation toward providing passive immunity and sufficient nutrients for the newborn lambs.

The fattening abilities and meat qualities of male and female lambs were studied, and new data regarding the meat productivity of Romanov lambs were obtained.

The established reproductive indicators show that the sheep of the Romanov breed are characterized by high reproductive potential, expressed through good conception rates and high values of biological and economic fecundity.

Despite the relatively small volume of the analyzed sample and its localization within a single flock, the results obtained show that the Romanov sheep included in our study have maintained the typical levels for the breed regarding the main productive and reproductive indicators, while new data on milk and meat productivity have been provided. The results of this study can be considered a basis for future larger-scale research.

IV. CONCLUSIONS

1. Male and female lambs of the Romanov breed show high growth intensity during the first 90 days. The highest average daily gain is recorded in the 60–90 day period (0.27 kg/day). Male lambs have a higher average daily gain and achieve a higher live weight than female lambs throughout the entire study period. At 90 days of age, males reach 24.06 kg, and female lambs reach 22.33 kg. Twin lambs are born with a higher live weight (3.30 kg) compared to lambs born as triplets (2.91 kg) ($p < 0.001$). Male and female twins maintain their superiority over male and female triplets at every age, but on the 30th, 60th, and 90th day, the weights of twins and triplets show close values. Female animals reach an average live weight of 31.37 kg at 6 months, 47.86 kg at 18 months, and 55.48 kg at 2.5 years.

2. The physicochemical composition of the colostrum of Romanov sheep was studied. During the first day after birth, the fat content varies between 10.78–12.41%, solids-not-fat from 17.89 to 20.93%, protein from 8.50 to 10.84%, and lactose 7.99–9.33%. During the second and third days after birth, a significant decrease in these indicators is observed, with fat content falling to 7.21–8.88%, protein to 5.01–6.54%, and lactose to 4.69–6.13%. The highest values are registered in ewes that gave birth to twins and triplets.

3. The highest average daily milk yield for the period of this study was recorded during the first control period – 0.62 l; during the course of lactation, milk yield gradually decreases and reaches 0.35 l at the IV control for the entire period ($p < 0.001$). The average lactational milk yield for the entire period is 59.45 l. The highest milk yield was registered in

ewes aged 4–5 years, while after the sixth year, the milk yield decreases statistically significantly ($p < 0.01$).

4. Ewes that gave birth to triplets have the highest lactational milk yield, followed by those with twins. The lowest lactational milk yield was found in ewes giving birth to one and four lambs ($p < 0.01$). In the analysis of the physicochemical parameters of the milk during lactation, an increase in fat content from 6.21% to 7.72% ($p < 0.001$) and total solids from 17.10% to 18.18% ($p < 0.01$) was established, while protein remains relatively stable and lactose decreases insignificantly.

5. Throughout the entire fattening period, the average daily gain in male Romanov lambs is 0.30 kg/day and 0.21 kg/day in females ($p < 0.01$). The average value of the live weight of males at the end of fattening (33.41 kg) is higher than that of females (27.15 kg) ($p < 0.05$). The consumption of feed, energy, and protein per 1 kg of gain in males is 4.93 kg, 5.64 FUG, and 483.33 g IDP, while in females – 5.74 kg, 6.70 FUG, and 579.35 g IDP.

6. The Romanov lambs investigated in our study show a high dressing percentage – 47.17% for males and 48.75% for females. In both sexes, the largest wholesale cut of the carcass is the leg; in this cut, as in the others, muscle tissue occupies the largest share. The analysis of the chemical composition and technological indicators confirms the meat quality of Romanov lambs, as the investigated indicators are similar for both sexes and both studied muscles.

7. The results obtained for the exterior measurements of male and female lambs at 30 and 90 days of age are comparable to those reported by other authors in previous studies. Male lambs at 30 and 90 days of age surpass female lambs in all exterior indicators. In the exterior measurements of female animals between the ages of 9 months and 2.5 years, an increase in mean values with age is observed; this change is most pronounced in oblique body length (from 65.39 to 72.77 cm) and chest girth (from 87.39 cm to 92.89 cm).

8. The amount of greasy wool in Romanov ewes aged 3–6 years (2.97 kg) significantly exceeds this indicator in those aged 1–2 (2.12 kg) and 7–8 years (2.01 kg) ($p < 0.05$). The average thickness of the undercoat fibers in the investigated flock of this breed is 11.35 μm , while that of the outercoat fibers (kemp/guard hair) is 39.33 μm ($p < 0.001$). It was found that the average fiber thickness in the thigh region (28.29 μm) surpasses that of the fibers in the shoulder region (23.07 μm).

9. During the three years of the study, the conception rate values vary between 83.61% and 89.47%, biological fecundity from 224.53% to 247.06%, and the values of economic fecundity remain constant at 177.05–177.57%. The average conception rate of the Romanov ewes established in the current study is 87.64%, with a biological fecundity of 236.28% and an economic fecundity of 177.55%. Multiple births predominate in the studied ewes, with the largest share being triplets (42.07%) and twins (40.24%), while singles (11.59%) and quadruplets (6.10%) occur with lower frequency.

V. RECOMMENDATIONS

1. The results obtained regarding the phenotypic parameters could serve to enrich the data used for updating the Breeding Program.

2. For the purpose of preserving the Romanov breed, the selection and mating of typical male and female animals born as twins and triplets should continue.

3. The study data on colostrum composition can be taken into account when optimizing nutrition, with the aim of increasing the survival rate of newborn lambs from multiple births.

VI. CONTRIBUTIONS

Scientific Contributions:

1. Data on the physicochemical composition of colostrum from the Romanov sheep breed are presented for the first time. The dynamics of indicators – fat, protein, lactose, and others – during the first three days after birth have been established. A significant influence of the number of lambs born on colostrum composition has been proven, with the highest values recorded in ewes that gave birth to twins and triplets.
2. The exterior measurements performed on animals from 30 days to 2.5 years of age allow for a comprehensive assessment of their growth and development, as well as supplementing the available information on the exterior indicators of animals of the Romanov breed.

Scientific and Practical Contributions:

1. The dynamics of live weight and average daily gain were tracked in Romanov lambs from birth to 90 days of age, and in female animals up to 2.5 years, under the conditions of the Fore-Balkan region. A statistically significant influence of sex and birth type on birth weight and early growth was established, with specific percentage differences determined between male and female lambs, as well as between twins and triplets. The results obtained supplement existing information regarding the growth potential of the lambs.
2. The dynamics of daily and lactational milk yield in Romanov ewes were determined, proving a statistically significant decrease in average daily milk yield during the course of lactation ($p < 0.001$). The average lactational milk yield for the entire study period was established (59.45 l), which contributes to the enrichment of existing scientific information on the productive capacities of the Romanov breed under specific rearing conditions.
3. The quantitative and qualitative traits of wool productivity – wool yield and fiber fineness – were studied. The study results were compared with data established by Bulgarian and foreign authors.

Practical Contributions:

1. The present study supplements scientific data on the carcass characteristics and meat quality of Romanov lambs. The findings confirm the high meat productivity and technological indicators of the meat from lambs of both sexes, providing a basis for their effective use in the meat processing industry.

VII. SCIENTIFIC PUBLICATIONS RELATED TO THE DISSERTATION

1. **Georgieva G.**, (2022). Romanov Sheep Breed as a Factor for Increasing Lamb Meat Yield. *Journal of Mountain Agriculture on the Balkans*, 25 (6), 138-153.
2. **Georgieva G.**, S. Stoycheva, Ts. Banchева, 2023. Dynamics of Live Weight in Romanov Lambs up to 90 Days of Age. *Journal of Mountain Agriculture on the Balkans*, 26 (3), 52-64.