Research paper
https://doi.org/10.52578/3134-8572-2026-1-27-40
IRSTI 68.39.31

PECULIARITIES OF MEAT PRODUCTIVITY IN PUREBRED AND CROSSBRED LAMBS

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For citation: Bexeitov T.K., Abeldinov R.B., Ateikhan B., Titanov Zh.E., Zhumabekova B.M. (2026). «PECULIARITIES OF MEAT PRODUCTIVITY IN PUREBRED AND CROSSBRED LAMBS», Animal Husbandry and Aquaculture, 1(1), 27-40, https://doi.org/10.52578/3134-8572-2026-1-27-40

ABSTRACT: The article presents the results of a study on the meat productivity of purebred and crossbred lambs obtained through industrial crossbreeding under farm conditions in the Pavlodar and Abai regions of Kazakhstan. The aim of the work was to study the influence of crossbreeding on the growth, development, and slaughter characteristics of young animals. The research methodology included the controlled slaughter of lambs aged 4–4.5 months, followed by measurements of pre-slaughter live weight, carcass weight, dressing percentage, and an analysis of carcass morphological composition. A detailed analysis of the ratio between muscle, fat, and bone tissues in the carcasses of lambs of different genotypes was carried out. Special attention was given to evaluating the meatiness coefficient as an objective indicator of meat productivity. The results showed that crossbred lambs generally demonstrated higher live weight and greater growth intensity compared to their purebred counterparts, indicating a positive heterosis effect. The analysis of carcass morphology revealed differences in tissue ratios depending on genotype, feeding level, and housing conditions. The obtained results confirm the expediency of using industrial crossbreeding to increase the meat productivity of sheep under the conditions of Kazakhstan and can be applied in breeding programs to improve meat quality and enhance the efficiency of mutton production.
KEYWORDS: lamb; sheep; crossbreeding; crossbred lambs; live weight; meatiness; carcass.
CONFLICT OF INTEREST: The authors declare that there is no conflict of interest.

FUNDING: This work was carried out within the framework of the program-targeted funding of the Ministry of Science and Higher Education of the Republic of Kazakhstan under the scientific and technical program IRN BR24992940 “Development of a Highly Productive Sheep Population in the Northeastern Region of Kazakhstan Based on Effective Breeding Methods and the Introduction of Resource-Saving Technologies” (2024-2026).

Article history:

Received: 25.11.25 Accepted: 19.01.26 Published: 28.03.26

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INTRODUCTION

Economy requires not only an increase in flock size, but also the creation of breeds that meet contemporary demands and are competitive not only on the domestic but also on international markets, that is, breeds possessing combined (dual-purpose) productivity.

Modern sheep production is aimed at the comprehensive enhancement of both breeding and productive traits through targeted selection and breeding programs that include improvement of heritable characteristics, optimization of feeding and housing, and the introduction of advanced reproductive technologies. Particular attention is paid to forming flocks of animals of the desired type, animals with high live weight, balanced conformation, robust constitution, and pronounced meat–fat characteristics, which ensures a high genetic potential for further breeding (Kineev et al., 2009; Erohin, 2023; Minahmetova, 2022; Maquivar et al., 2021).

The formation of meat productivity in sheep is closely linked to their level of energy metabolism, the intensity of fattening, and body conformation. The principal indicators are slaughter weight, dressing percentage, carcass weight, morphological composition, and meatiness coefficients, which reflect both breed-specific features and the effectiveness of breeding work.

Meat productivity is a key parameter that determines an animal's meat value and its ability to gain live weight and produce carcasses of the required weight and quality within a given time frame. The concept encompasses both quantitative and qualitative traits. Quantitative characteristics include live weight, carcass weight, and dressing percentage; qualitative traits include marbling, muscle structure, composition of the fat fraction, and the nutritional and organoleptic properties of the product (flavor, aroma, juiciness, etc.). Assessment of meat productivity is based on the combination of these indicators and must take into account the animals' age and sex, housing conditions, and fattening technology (Hopkins, 2011; Aouina et al., 2025; Zhumadillayev, 2023; Esengaliev et al., 2023).

The primary aim of increasing meat productivity is to obtain a larger volume of marketable meat in a shorter time, with optimal feed and labor costs, without deteriorating product quality. This implies achieving high average daily gains, efficient feed conversion, a stable and high dressing percentage, and compliance of the sensory and nutritional characteristics of the meat with market requirements. Economically justified productivity gains must be combined with maintaining herd sustainability (low morbidity, high lamb survival) and take into account the ecological and social constraints of the given region (Pogodaev et al., 2023; Aidyn et al., 2024; Udo et al., 2011; Deniskova et al., 2018).

Purebred breeding ensures stability of heritable traits, predictability of productive qualities, and the possibility of selective breeding. At the same time, industrial crossbreeding is employed to produce crossbred animals that combine the positive qualities of parental forms, meat breeds, and highly adapted maternal lines. Its principal advantage is the manifestation of heterosis, expressed as increased viability, accelerated growth, and improved slaughter traits of the offspring (Landim et al., 2021).

The primary objective is to ensure rapid and reliable production of marketable young stock with predictable productive and commercial traits.

In this context, industrial crossbreeding using specialized meat and meat-and-wool breeds is of particular scientific and practical interest, as it may improve growth intensity and slaughter traits while maintaining the adaptive characteristics of local sheep populations. However, the effectiveness of industrial crossbreeding largely depends on the correct selection of parental forms and requires a comprehensive assessment of the meat productivity and slaughter qualities of the resulting offspring under specific environmental and management conditions (Xie et al., 2025; Wang et al., 2025).

The relevance of selecting the Kazakh coarse-wool and Kazakh semi-coarse-wool breeds as maternal forms is due to their wide distribution, high adaptation to pasture-based production systems, resistance to diseases, and satisfactory reproductive performance. These breeds are traditionally used in extensive and semi-intensive sheep production systems and represent promising genetic resources for improving meat productivity.

The use of Meat Merino and Kazakh meat-and-wool rams as paternal forms is justified by their pronounced meat qualities, high precocity, intensive growth, and good carcass muscling. The combination of these breeds within industrial crossbreeding schemes allows the evaluation of the influence of different genotypes on the formation of meat productivity and slaughter traits of lambs, as well as the identification of the most promising options for practical application in commercial sheep production.

The aim of the present study was to conduct a comparative evaluation of the meat productivity and slaughter qualities of purebred and crossbred ram lambs of different genotypes, obtained through pure breeding and industrial crossbreeding, under the conditions of farms located in the Pavlodar and Abai regions of the Republic of Kazakhstan.

To achieve this aim, the following objectives were set:

– to study live weight of lambs at birth and at 4-4.5 months of age under pure breeding and industrial crossbreeding;

– to determine absolute and average daily weight gains of ram lambs of different genotypes;

– to evaluate slaughter traits of young stock, including pre-slaughter live weight, carcass weight, slaughter weight, and dressing percentage;

– to analyze the morphological composition of carcasses and the proportions of muscle, fat, and bone tissues;

– to calculate meatiness coefficients and provide a comprehensive assessment of meat productivity of purebred and crossbred animals;

– to determine the efficiency of industrial crossbreeding for improving meat productivity of sheep under the conditions of the studied farms.

Sheep breeding plays an important role in ensuring food security and sustainable livestock production in many regions of the world. The economic efficiency of the industry is largely determined by the level of mutton production, the demand for which has increased in recent years. Therefore, improving meat productivity and growth performance of sheep remains an important task for increasing the profitability and competitiveness of sheep farming (Kineev et al., 2009; Minakhmetova, 2022).

Kazakhstan possesses extensive natural pasture resources that provide favorable conditions for the development of sheep breeding. Among the most widespread breeds are the Kazakh coarse-wool fat-tailed sheep and the Kazakh semi-coarse-wool fat-tailed sheep. These breeds are characterized by high adaptability to harsh climatic conditions and extensive pasture systems while maintaining satisfactory meat productivity (Kineev et al., 2009). As a result, they represent valuable genetic resources for the development of sheep production in the country.

Despite the high adaptive potential of local breeds, increasing productivity and economic efficiency remains an important challenge for modern sheep breeding. One of the most effective approaches to address this issue is the use of crossbreeding systems aimed at improving growth rate, carcass quality, and slaughter characteristics (Erohin, 2023; Pogodaev et al., 2023). Crossbreeding allows the combination of desirable traits of different breeds and often results in the manifestation of heterosis, expressed in higher growth intensity, improved feed efficiency, and better carcass performance (Petrovic et al., 2019; Afolayan et al., 2008; Abdulkhaliq, 2002).

International studies also confirm that crossbreeding strategies can significantly increase meat productivity while maintaining the adaptive traits of local breeds (Landim et al., 2021; Aidyn et al., 2024). In addition, modern genetic studies have identified genes associated with fat deposition and carcass traits in sheep, including PDGFD, which plays an important role in the formation of fat-tail characteristics (Li et al., 2018; Dong et al., 2020; Xie et al., 2025; Wang et al., 2025).

Thus, the effective use of local genetic resources combined with industrial crossbreeding systems is considered a promising approach for improving meat productivity and increasing the efficiency of sheep production in Kazakhstan.

METHODS OF THE RESEARCH

The research on evaluating meat productivity and slaughter qualities of sheep was conducted under the conditions of two farms: LLP "Ak Bas-Pavlodar" (Pavlodar region) and KH "Bepen" (Abai region), Kazakhstan. The objects of the study were purebred and crossbred ram lambs, divided into four experimental groups according to genotype:

- CW: Kazakh coarse-wool breed;
- CW×MM: Crossbreds of Kazakh coarse-wool ewes with *Meati Merino* rams;
- SCW: Kazakh semi-coarse-wool breed;
- SCW×MW: Crossbreds of Kazakh semi-coarse-wool ewes with *Kazakh meat-and-wool* (MW) rams.

At LLP "Ak Bas-Pavlodar", the experimental groups were formed as follows:

- For pure breeding, first-class ewes and elite-class rams of the Kazakh coarse-wool breed (CW) were used.
- For industrial crossbreeding, first-class ewes of the CW breed and elite-class rams of the *Meat Merino* (MM) breed were used.

At "Bepen" farm (Abai region):

- For pure breeding, first-class ewes and elite-class rams of the Kazakh semi-coarse-wool breed (SCW) were used.
- For industrial crossbreeding, first-class ewes of the (SCW) breed and elite-class rams of the *Kazakh meat-and-wool* (MW) breed were used.

To perform both industrial and pure breeding programs, specific mating schemes were developed (Fig. 1-2), ensuring the accuracy of genetic combinations and the comparability of experimental results.

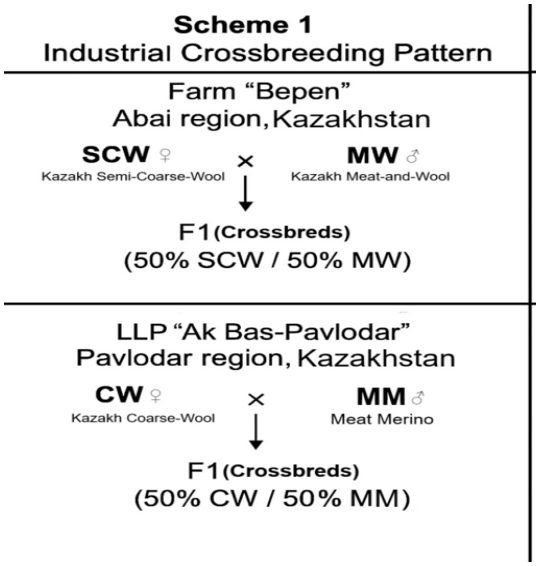

Figure 1. Industrial Crossbreeding Pattern

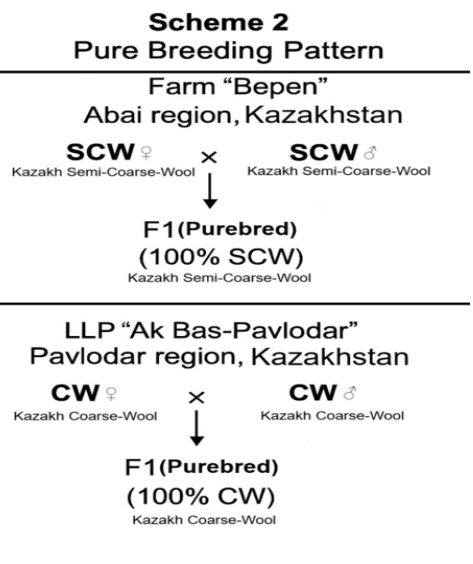

Figure 2. Pure Breeding Pattern

For the assessment of in vivo indicators of meat productivity, each experimental group consisted of 30 ram lambs, which were selected according to the principle of analogs (age, live weight, and physiological condition).

During the study, in vivo indicators of meat productivity were examined, including live weight at birth and at 4 to 4.5 months of age, as well as absolute and average daily weight gain of lambs in both experimental and control groups.

The productive characteristics of the experimental animals (live weight) were evaluated according to the Instruction for the Appraisal of Sheep (Ministry of Agriculture of the Republic of Kazakhstan, 2015).

Live weight (LW) was determined by individual weighing of each animal using platform electronic scales with an accuracy of 0.1 kg.

Growth and development of young lambs were assessed based on live weight at birth and at 4–4.5 months of age (weaning period). Live weight was measured individually at two stages:

- at birth;

at 4–4.5 months (weaning).

The absolute weight gain (ΔM) was calculated as the difference between the final and initial live weights of the animal during a specific growth period, using the formula:

$$\Delta M = M_2 - M_1 \quad (1)$$

where M2: final live weight (kg), M1: initial live weight (kg).

The average daily gain (ADG) was calculated using the following equation:

$$ADG = \frac{M_2 - M_1}{t} \quad (2)$$

where $M2$: final live weight (kg); $M1$: initial live weight (kg); t: duration of the period (days).

To determine post-slaughter indicators of meat productivity, a control slaughter was carried out on 5 ram lambs from each experimental group, selected from animals with live weight close to the group average.

During control slaughter, the following parameters were recorded:

- pre-slaughter live weight;
- carcass weight (warm carcass);
- slaughter weight;
- dressing percentage (%).

Qualitative meat characteristics: Such as the ratio of muscle, fat, and bone tissues, were determined by carcass dissection. Based on these data, meatiness coefficients were calculated (ratios of muscles to bones and muscles to fat).

The meatiness coefficient is an indicator that characterizes the meat quality of the animal, reflecting the ratio of muscle mass to bone mass in the carcass and serving as an objective measure of carcass composition:

$$K_m = \frac{M_m}{M_k} \quad (3)$$

where Mm: muscle mass (kg) and Mk: bone mass (kg).

Statistical processing of the obtained data was performed using methods of variation statistics. The calculation of mean values (M), standard deviation (SD), and standard error of the mean (m) was carried out using Microsoft Excel software. Statistical significance of differences between groups was determined using Student's t-test, with the level of significance set at $p < 0.05$.

RESULTS

One of the most important indicators characterizing the growth, development, productivity, and reproductive qualities of animals is live weight. Understanding the patterns of live weight change with age is essential for comparing and evaluating animals at different stages of life. The productivity level is largely correlated with body size and the dynamics of live weight during rearing.

Numerous factors affect the live weight of animals, including sex, age, breed, body condition, feeding level, and health status. The main indicators of growth and development are live weight and its increase over time. These are crucial economic and biological traits that characterize the degree of an organism's development, its level of meat productivity, and the efficiency of its use in production.

Growth and development are considered from two perspectives:

- as an increase in body size and live weight;
- and as the development or change in body proportions during the growth process.

In vivo assessment of meat productivity is an important element of breeding work, enabling the timely identification of animals with high genetic potential, optimization of selection, and improvement of overall efficiency in meat-oriented sheep production.

The most common methods for studying animal growth in zootechnical practice are periodic weighing and body measurements. In this study, the live weight of lambs was determined at birth and at 4–4.5 months of age. The data on live weight and growth rates of ram lambs at these ages are presented in Table 1 below.

Table 1. Changes in Live Weight of Ram Lambs with Age (n=30)

№	Farm	Breed Combination	Live Weight		Live Weight Gain from Birth to 4–4.5 Months	
			At Birth, kg	At 4–4.5 Months, kg	Absolute Gain (kg)	Average Daily Gain (g)
1	LLP “KH Ak Bas-Pavlodar”	(CW x CW) n=30	4,7±0,07	36,7±0,33	32,0±0,32	267±2,55
		(MM x CW) n=30	4,3±0,07	38,2±0,28 ***	33,9±0,28	282±2,22
2	KH “Bepen”	(SCW x SCW) n=30	4,41±0,06	38,3±0,31	33,9±0,31	283±2,64
		(MW x SCW) n=30	5,03±0,04	38,4±0,27**	33,4±0,26	278±2,21
Statistical significance of differences between groups — *P < 0.05; **P < 0.01; ***P < 0.001.						

Table 1 shows the changes in live weight of ram lambs from birth to 4–4.5 months of age in two farms under purebred breeding and industrial crossbreeding. At LLP “KH Ak Bas-Pavlodar,” purebred CW×CW lambs had an average live weight of 4.7±0.07 kg at birth, reaching 36.7±0.33 kg by 4–4.5 months, corresponding to an absolute gain of 32.0±0.32 kg and an average daily gain of 267±2.55 g. Crossbred MM×CW lambs had a lower birth weight of 4.3±0.07 kg, but by weaning their weight increased to 38.2±0.28 kg, with an absolute gain of 33.9±0.28 kg and an average daily gain of 282±2.22 g. The significance of differences between the groups for absolute gain and average daily gain was noted as ***P < 0.001, indicating a high statistical significance of the crossbred lambs’ advantage in growth rate.

At KH “Bepen,” purebred SCW×SCW lambs weighed 4.41±0.06 kg at birth and reached 38.3±0.31 kg at 4–4.5 months, with an absolute gain of 33.9±0.31 kg and an average daily gain of 283±2.64 g. Crossbred MW×SCW lambs had a higher birth weight of 5.03±0.04 kg, reaching 38.4±0.27 kg at weaning, with an absolute gain of 33.4±0.26 kg and an average daily gain of 278±2.21 g. The significance of differences between purebred and crossbred lambs in this farm was noted as **P < 0.01, confirming the statistically significant effect of genotype on the growth rate of live weight.

Thus, the data in table 1 demonstrate that the growth of ram lambs depends both on genotype and the farm conditions. Crossbred lambs at LLP “KH Ak Bas-Pavlodar” showed a higher growth intensity compared to their purebred counterparts, while at KH “Bepen” purebred SCW×SCW lambs had a slightly higher average daily gain than crossbreds. The statistical significance of the differences confirms the reliability of the observed patterns, and the mean values with standard errors reflect the stability of weight and growth indicators within each group.

Enhancing meat productivity and slaughter characteristics of sheep is a key direction in the intensification of sheep production, aimed at obtaining high-quality lamb meat with minimal feed and resource expenditure. Meat productivity is determined by indicators such as live weight,

dressing percentage, and carcass morphological composition, whereas slaughter qualities are characterized by pre-slaughter live weight, carcass weight, yields of meat, fat, and bones, and the meatiness coefficient.

Modern zootechnical approaches focus on:

- targeted selection of animals for live weight, conformation, and precocity;
- use of high-performance breeding rams;
- improvement of feeding systems with optimal protein and energy balance;
- implementation of intensive fattening technologies.

Particular attention is paid to developing meat-fat and meat-wool types of sheep, which combine high productivity with adaptability to various climatic conditions.

To assess slaughter qualities, a control slaughter of purebred and crossbred ram lambs of different genotypes was conducted (see Figure 1). The results of slaughter indicators are presented in Table 2 below.

Table 2. Slaughter Performance of 4-4.5-Month-Old Ram Lambs (n=5)

Breed Combination	Farm	Pre-slaughter Live Weight (kg)	Carcass Weight		Fat tail weight		Visceral fat mass		Slaughter weight	
			kg	%	kg	%	kg	%	kg	%
CW, n=5	LLP "Ak Bas-Pavlodar"	39,4 ±49,26	20,0 ±24,95	50,8	2,1 ±2,68	5,3	0,3 ±0,38	0,7	20,3 ±26,68	51,5
CW×MM, n=5	LLP "Ak Bas-Pavlodar"	43,5 ±54,33	23,0 ±28,76	52,8	-	-	0,5 ±0,65	1,1	23,5 ±29,43	54,0
SCW, n=5	"Bepen"	42,5 ±53,08	21,0 ±25,83	49,4	2,0 ±2,55	4,7	0,25 ±0,31	0,5	21,2 ±26,53	49,9
SCW×MW, n=5	"Bepen"	46,0 ±57,51	24,0 ±30,01	52,1	-	-	0,8 ±1,0	1,7	24,8 ±30,98	54,0

Table 2 presents the slaughter performance of 4–4.5-month-old ram lambs of different genotypes. At LLP "Ak Bas-Pavlodar," purebred CW lambs had a pre-slaughter live weight of 39.4±49.26 kg and a carcass weight of 20.0±24.95 kg, corresponding to a dressing percentage of 50.8%. The fat tail weighed 2.1±2.68 kg (5.3% of pre-slaughter weight), and the internal fat was 0.3±0.38 kg (0.7%), resulting in a total slaughter weight of 20.3±26.68 kg and a final dressing percentage of 51.5%. Crossbred CW×MM lambs showed higher performance: pre-slaughter weight 43.5±54.33 kg, carcass weight 23.0±28.76 kg, dressing percentage 52.8%, internal fat 0.5±0.65 kg (1.1%), total slaughter weight 23.5±29.43 kg, and final dressing percentage 54.0%. This indicates an improvement in slaughter productivity with industrial crossbreeding.

At the "Bepen" farm, purebred SCW lambs had a pre-slaughter live weight of 42.5±53.08 kg and carcass weight of 21.0±25.83 kg (dressing percentage 49.4%), fat tail 2.0±2.55 kg (4.7%), and internal fat 0.25±0.31 kg (0.5%), giving a total slaughter weight of 21.2±26.53 kg and dressing percentage of 49.9%. Crossbred SCW×MW lambs showed higher values: pre-slaughter weight 46.0±57.51 kg, carcass weight 24.0±30.01 kg, dressing percentage 52.1%, internal fat 0.8±1.0 kg (1.7%), total slaughter weight 24.8±30.98 kg, and dressing percentage 54.0%.

Thus, the data from the table demonstrate that crossbred lambs at both LLP "Ak Bas-Pavlodar" and "Bepen" farms have higher carcass weight, total slaughter weight, and dressing percentage compared to purebred counterparts, confirming the effectiveness of industrial crossbreeding in improving meat productivity. The standard deviations reflect the variability of the indicators within each group.

It should also be noted that the crossbred lambs lacked tail fat, a trait associated with meat-type sheep and indicative of improved carcass composition (Fig. 3).

The analysis of slaughter data revealed pronounced differences in meat productivity between purebred and crossbred ram lambs, reflecting the influence of breed composition on slaughter performance.

The higher pre-slaughter live weight and carcass mass in the crossbred groups CW×MM and SCW ×MW demonstrate a greater growth potential and live-weight intensity, indicating their advantage in meat productivity.

Figure 3. Determination of pre-slaughter weight and post-slaughter weight

A distinctive feature of crossbred lambs CW×MM and SCW×MW is the increased internal fat deposition (0.5-0.8 kg) combined with the absence of tail fat, which is typical for crosses with enhanced meat traits. This corresponds to the selective breeding objectives aimed at reducing the proportion of tail fat deposits while preserving the overall energy value of the carcass.

The study of the morphological composition of sheep carcasses is an important area of zootechnical research, as it allows for a comprehensive evaluation of meat productivity, product quality, and biological value.

The morphological composition includes determining the ratio of the main tissues, muscle, fat, bone, and connective, within the carcass, which serves as a key criterion in assessing the meat qualities of animals (Fig. 4).

Figure 4. Boning of carcasses

For meat-oriented sheep breeding, particular importance is given to the meatiness coefficient, the proportion of muscle tissue, the distribution of internal fat, and the ratio of edible parts of the carcass to bone mass.

The analysis of carcass morphology makes it possible to evaluate not only slaughter performance but also the effectiveness of breeding work, feeding practices, and fattening technologies. In this regard, we determined the morphological composition of carcasses in the studied ram lambs of different genotypes; the results are presented in Table 3.

Table 3. Morphological Composition of Carcasses of 4–4.5 – Month-Old Ram Lambs (n=5)

Breed Combination	Farm	Carcass Weight (kg)	Muscle Tissue (Lean Meat)		Bones	
			кг	%	кг	%
CW	LLP "Ak Bas-Pavlodar"	20	15,6	78	4,4	22
CW×MM	LLP "Ak Bas-Pavlodar"	23	19,1	83	3,9	17
SCW	"Bepen"	21	17,0	80,1	4,0	19,9
SCW×MW	"Bepen"	24	20,1	83,8	3,9	16,2

In terms of carcass morphological composition, the crossbred ram lambs CW×MM and SCW×MW were characterized by a higher yield of lean meat. The crossbred CW×MM and SCW×MW lambs exceeded their purebred counterparts in this indicator by 5 % and 3.7 %, respectively. The bone yield across the groups ranged from 3.9 to 4.4 kg, or 16.2 to 22 %, which corresponds to zootechnical standards for meat–fat type sheep and indicates well-developed meat conformation.

An objective indicator used to evaluate the meat productivity of animals is the meatiness coefficient. In our study, the coefficient for CW ×MM crossbreds was 0.28 units higher compared with purebred animals. This indicates a more favorable ratio of edible to inedible carcass parts in the crossbreds, which is especially important in intensive meat sheep production (Fig. 5).

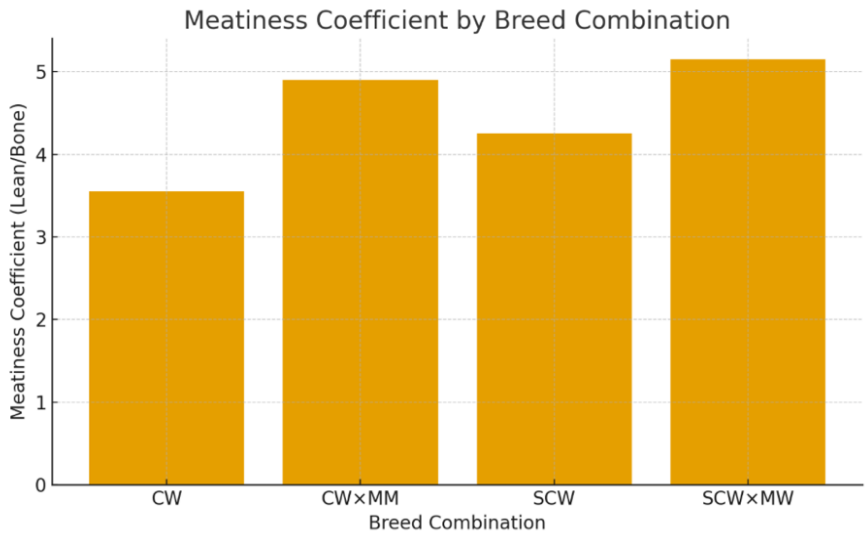

Figure 5. Meatiness Coefficient of Ram Lambs Aged 4-4.5 Months

The analysis of Figure 5 shows that assessment of the ratio between muscle tissue mass and bone mass revealed significant differences among the groups. The highest meatiness coefficient was recorded in the crossbred group SCW×MW (5.15), indicating a pronounced advantage of this combination in terms of muscle tissue development and minimal bone content in the carcass. The second-highest value was observed in the CW×MM (4.90) group, which also demonstrates a high dressing yield and a favorable morphological composition of the carcass.

In the SCW group, the meatiness coefficient amounted to 4.25, which corresponds to an average level and is somewhat lower compared to the crossbred variants. The lowest coefficient was found in the purebred CW group (3.55), indicating a higher proportion of bone and consequently lower meat productivity.

Thus, the obtained data confirm the advantages of crossbred animals, particularly the SCW×MW combination, which shows the most favorable lean-to-bone ratio and the highest economic value for meat production.

Conclusion. Overall, the obtained data indicate high meat productivity in both purebred and

crossbred ram lambs. However, the use of crossbred animals with improved meat traits represents a promising direction for breeding and increasing the efficiency of meat sheep production.

Industrial crossbreeding contributes to the improvement of in vivo indicators of meat productivity through the heterosis effect, which manifests itself in faster growth, better muscling, and a more balanced body conformation in crossbred animals.

In the studied farms, crossbred ram lambs exhibited higher live weight and more harmonious body development compared with purebred counterparts. The dynamics of live weight from birth to 4–4.5 months demonstrated the advantage of crossbred groups (SCW ×MW and CW ×MM) in both growth rate and final live weight, while maintaining strong body constitution.

The heterosis effect was expressed through greater growth energy, uniform development, and higher slaughter yield in crossbred young stock.

Crossbred lambs (CW ×MM and SCW ×MW) surpassed purebred contemporaries in slaughter yield, carcass weight, and meatiness coefficient, while having a lower proportion of fat and bone tissues, an especially important factor for meat-oriented sheep breeding.

The conducted research demonstrated that industrial crossbreeding (CW ×MM and SCW ×MW) increases pre-slaughter live weight, slaughter performance, and meatiness coefficient, indicating a predominant development of meat traits in crossbred lambs.

This confirms the feasibility of using crossbreeding to enhance efficiency and productivity under the conditions of intensive meat sheep farming in Kazakhstan.

DISCUSSION

The results obtained in the present study confirm the effectiveness of industrial crossbreeding as a method for improving meat productivity in sheep under the conditions of Kazakhstan. Crossbred ram lambs demonstrated higher growth rates, increased carcass weight, and improved slaughter characteristics compared to purebred animals.

The higher live weight and average daily gain recorded in crossbred lambs can be explained by the heterosis effect, which manifests itself in improved vitality, faster growth, and better feed utilization. Similar patterns were described by Afolayan et al. (2008), who noted that crossbreeding positively affects growth performance and carcass yield in lambs.

Another important finding of this study is the improvement in carcass morphological composition in crossbred animals. The higher proportion of muscle tissue and lower bone content observed in crossbred lambs indicate better meat conformation and higher economic value of carcasses. According to Hopkins et al. (2011), the ratio of muscle to bone tissue is one of the most reliable indicators of meat productivity and carcass quality.

The absence of tail fat in crossbred lambs, combined with increased internal fat deposition, suggests a shift toward a more meat-type carcass structure. This observation is consistent with genetic studies that demonstrate the influence of selective breeding on fat deposition patterns in sheep (Li et al., 2018; Dong et al., 2020). Such characteristics are desirable in modern meat sheep production, where lean meat yield and carcass quality are key economic factors.

It should also be noted that environmental and management factors, including feeding level and farm conditions, may influence the manifestation of genetic potential. Differences observed between the farms in the present study indicate that optimal feeding and management systems are essential for maximizing the productive advantages of crossbred animals.

Overall, the obtained results confirm that the use of specialized meat breeds in industrial crossbreeding programs can significantly enhance meat productivity and improve carcass characteristics of lambs under practical farming conditions.

CONCLUSION

The conducted research demonstrated that both purebred and crossbred ram lambs possess relatively high meat productivity; however, crossbred animals showed clear advantages in growth performance, slaughter traits, and carcass composition.

Crossbred lambs obtained from Kazakh coarse-wool and Kazakh semi-coarse-wool ewes crossed with Meat Merino and Kazakh meat-and-wool rams exhibited higher live weight at weaning, increased average daily gain, and improved slaughter yield compared with purebred animals. These differences indicate the positive manifestation of heterosis and confirm the effectiveness of industrial crossbreeding.

The morphological analysis of carcasses showed that crossbred lambs had a higher proportion of muscle tissue and a lower proportion of bone tissue, resulting in a higher meatiness coefficient. This demonstrates the formation of carcasses with improved meat characteristics and greater economic value.

The results obtained in this study confirm that industrial crossbreeding using specialized meat breeds is a promising approach for increasing the efficiency of sheep production in Kazakhstan. The application of such breeding strategies can contribute to the development of highly productive sheep populations and to the improvement of lamb meat production under local environmental and management conditions.

Therefore, the use of crossbreeding programs involving Kazakh local breeds and specialized meat breeds can be recommended as an effective tool for improving meat productivity and enhancing the competitiveness of sheep farming in the northeastern regions of Kazakhstan.

ACKNOWLEDGEMENTS

The authors sincerely acknowledge the support provided by all colleagues involved in this research and the guidance offered by scientific advisors. They are also grateful to the teams of “AkBas-Pavlodar” LLP and “Bepen” for facilitating the practical implementation of the study results..

AUTHOR CONTRIBUTIONS

Conceptualization and theory: TB, RA and BA; research design: TB and RA; data collection: BA, ZT and BZ; analysis and interpretation: TB, RA and ZT; writing draft preparation: TB and BA; supervision: TB; correction of article: RA and ZT; proofread and final approval of article: TB, RA, BA, ZT and BZ. All authors have read and agreed to the published version of the manuscript.

ETHICAL ASPECTS

All procedures involving animals in this study were carried out in accordance with the ethical standards for the care and use of agricultural animals in scientific research. The experimental work complied with the national guidelines and regulations of the Republic of Kazakhstan concerning animal welfare. All efforts were made to minimize animal stress and ensure humane treatment during weighing, handling, and control slaughter procedures.

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ТҮЙІН

Мақалада Қазақстанның Павлодар және Абай облыстары жағдайында өндірістік будандастыру арқылы алынған таза тұқымды және будан қозылардың ет өнімділігіне жүргізілген зерттеу нәтижелері қарастырылған. Зерттеудің негізгі мақсаты – будандастырудың жас малдың өсу қарқынына, даму ерекшеліктеріне және сойыс көрсеткіштеріне әсерін анықтау, сондай-ақ будан ұрпақтың ет өнімділік қасиеттерін жан-жақты бағалау болып табылады. Қазіргі таңда қой шаруашылығында жоғары сапалы ет өндіру және өндіріс тиімділігін арттыру үшін өндірістік будандастыру әдістерін қолдану маңызды бағыттардың бірі болып саналады, себебі бұл әдіс генетикалық әлеуетті арттыруға және гетерозис эффектісін пайдалануға мүмкіндік береді.

Зерттеу жұмыстары шаруашылық жағдайында жүргізілді. Тәжірибе барысында әртүрлі генотипке жататын қозылар өсіріліп, олардың тірі салмақтарының өзгеруі, өсу қарқыны, жалпы даму көрсеткіштері және дене компоненттерінің арақатынасы бақылауға алынды. Зерттеу әдістемесіне сәйкес 4-4,5 айлық қозыларға бақылаулы сою жүргізілді. Сою алдында тірі салмақ анықталып, союдан кейін ұша салмағы, сойыс шығымы және ұшаның морфологиялық құрамы зерттелді. Сонымен қатар ұшаның бұлшықет, май және сүйек тіндерінің арақатынасына салыстырмалы талдау жасалды. Ет өнімділігінің маңызды көрсеткіштерінің бірі ретінде еттілік коэффициенті есептеліп, әртүрлі генотиптегі қозылар арасында салыстырылды.

Зерттеу нәтижелері будан қозылардың таза тұқымды қозылармен салыстырғанда тірі салмағының жоғары екенін, өсу қарқынының қарқындырақ болатынын және бұлшықет тінінің үлесі жоғары екенін көрсетті. Бұл будандастыру кезінде байқалатын гетерозис әсерінің оң ықпалын дәлелдейді. Сонымен қатар будан қозылардың ет сапасы жақсы көрсеткіштерге ие екені анықталды. Жалпы алғанда, алынған нәтижелер Қазақстан жағдайында қой етінің өнімділігін арттыру мақсатында өндірістік будандастыруды қолданудың тиімді екенін көрсетеді. Нәтижелер селекциялық-асылдандыру жұмыстарына, сондай-ақ қой етін өндірудің экономикалық тиімділігін арттыруға бағытталған өндірістік бағдарламаларды жетілдіруде қолданылуы мүмкін.

РЕЗЮМЕ

В статье представлены результаты исследования мясной продуктивности чистопородных и помесных ягнят, полученных путем промышленного скрещивания в условиях Павлодарской и Абайской областей Казахстана. Основная цель работы – изучение влияния скрещивания на скорость роста, особенности развития и показатели убоя молодняка, а также комплексная оценка мясной продуктивности помесного потомства. В настоящее время применение методов промышленного скрещивания является одним из ключевых направлений в овцеводстве для повышения качества мяса и эффективности производства, поскольку данный подход позволяет увеличить генетический потенциал и использовать эффект гетерозиса.

Исследование проводилось в хозяйственных условиях. В ходе опыта выращивались ягнята различных генотипов, контролировались изменения их живой массы, скорость роста,

общие показатели развития и соотношение компонентов тела. В соответствии с методикой исследования, контролируемый убой проводился для ягнят в возрасте 4-4,5 месяца. Перед убоем определялась живая масса, после убоя – масса туши, убойный выход и морфологический состав туши. Также проводился сравнительный анализ соотношения мышечной, жировой и костной ткани. В качестве одного из ключевых показателей мясной продуктивности рассчитывался коэффициент мясистости и сравнивался между ягнятами разных генотипов.

Результаты исследования показали, что помесные ягнята имели более высокую живую массу и более интенсивный рост по сравнению с чистопородными аналогами, что подтверждает положительное влияние гетерозиса при скрещивании. Кроме того, анализ морфологического состава туши показал более высокую долю мышечной ткани у помесных ягнят и хорошие показатели качества мяса. В целом полученные данные подтверждают эффективность применения промышленного скрещивания для повышения мясной продуктивности овец в условиях Казахстана. Результаты могут быть использованы в селекционно-племенной работе, а также для совершенствования производственных программ, направленных на повышение экономической эффективности производства овечьего мяса.

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