RESEARCH ON THE HETEROSIS EFFECT FOR MEAT PRODUCTION IN CROSSBREEDS OBTAINED FROM THE CROSSING OF ȚIGAIE SHEEP WITH MEAT BREED RAMS

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Abstract

The purpose of this research was to evaluate the effect generated by the use of meat breed rams from the Vandeen, Blanche du Masif Central, and Berrichon du Cher breeds on the main indicators specific to sheep meat production. The biological material consisted of F1 crossbred lambs resulting from crossing of these breeds with local Țigaie ewes—rusty variety. The evaluation period was during the lambs' suckling phase. Based on the values obtained at weaning, the average daily weight gain and the total weight gain over the 75-day suckling period were determined. The differences registered between the performance of Țigaie breed lambs and crossbred lambs are obvious and have a high level of statistical significance ($p \leq 0.001$) for both total weight gain and average daily weight gain.

Key words: *Țigaie sheep breed, sheep meat, heterosis, growth intensity, average daily gain*

INTRODUCTION

The major role of organizing this type of scientific research it is revealed by the quality and volume of information that can be used to organize the systematic production of lamb meat in Romania. The importance and relevance of the study consists also ensured by the fact that some results can be used to define the basic elements that may be included in an efficient technological process for systematic sheep meat production. This last aspect is extremely important because ensuring regular and optimal supply to both the domestic and external markets with sheep meat involves a shift in perspective at the farm level and requires moving from producing sheep meat, as a by-product of sheep dairy farming, to organizing the systematic and continuous production of this commodity.

Based on this type of results, efficient managerial activities can also be defined and implemented, which can generate optimal use of all local resources without having a major impact on environmental factors by intensifying production [1]. The current context is favorable for developing efficient sheep meat production programs because meat production in Europe is declining, meaning that the EU now imports more sheep meat than ever before [2]. This is largely due to the fact that in many European countries, sheep meat production is not organized on sustainable principles.

Sheep meat and dairy production is an important industry in Europe, especially in countries such as Ireland, France, Italy, Romania, Spain, and the United Kingdom. In fact, with 85 million sheep on 830.000 farms in the EU, plus another 33 million sheep in Turkey, Europe's flock is larger than that of Australia and New Zealand

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combined. However, even with this large number of sheep, Europe is only 85% self-sufficient in sheep meat. As a result, the EU is the second largest importer of sheep meat in the world. This gap is due to the way production activities are organized. Since 2000, the number of sheep product suppliers in the EU has decreased by 50%, and in the last 10 years, sheep productivity has fallen by up to 40% (depending on the country and the farming system). Various factors may explain this decline, but the main one is the low productivity of sheep or the reduced number of lambs obtained from each female [3].

MATERIAL AND METHOD

The main objective of the research was to optimize all factors that can be used to evaluate the performance of the two F1 crossbreed groups in order to objectively determine not only the heterosis effect but also the main indicators on which lamb meat production depends.

The biological material consisted of first-generation (F1) individuals resulting from the crossing of French meat breed rams (Vandeen, Berrichon du Cher, and Blanche du Masif Central) with local adult ewes belonging to the rusty variety of the Țigaie breed. The breeding season was placed in the natural period, specifically in September-October of the previous year. Throughout the gestation period, the pregnant ewes were kept in separate compartments and in distinct groups, with all welfare standards being respected.

The feeding of the pregnant ewes was done with diets designed to meet all their daily nutritional requirements. These diets were periodically modified according to the physiological state of the ewes, and the feed was administered as a single mixture, available at will.

The lambing season took place in the spring of the following year, with all standards and requirements being ensured to avoid unforeseen and negative situations. During the night, responsible personnel were assigned for supervision and intervention.

Lambing took place in specially arranged spaces where each mother ewe and lamb pair could have privacy and favorable conditions. 24 hours after lambing, the youth was weighed, thus recording their birth weight. At the same time, the lambs were phenotypically analyzed and individualized.

Considering that the research focused on analyzing the growth intensity of lambs during the suckling period, additional weighing was performed at 30 days, 60 days, and 90 days after birth. For weighing, a decimal scale with an accuracy of ±100g was used.

The results obtained were entered into the database and used to run statistical analyses with the REML (Restricted Maximum Likelihood) algorithm, which allows an analysis of estimators under normal limit conditions. Additionally, the REML estimator allows for the maximization of the estimation of parameter probability by using only the information not contained in the estimation of the regression vector, and therefore, it automatically corrects the values of the degrees of freedom lost in the estimation of the regression vector.

RESULTS AND DISCUSSIONS

Using crossbreeding to produce crossbreeds of different generations is a common and effective practice. This is also the basic method involved in obtaining lambs destined for fattening in countries such as England, Ireland, Scotland, as well as in France, Germany, and Italy [1].

The systematic production of meat through the use of crossbred sheep populations is important because it is based on the observation that these individuals are generally superior to the initial populations from which the parent stock originates. The high biological value characteristic of crossbred lambs is due to the fact that their

bodies synthesize hormones, enzymes, and biostimulators with increased efficiency [4]. Another explanation could be that due to the combination of several valuable traits and characteristics, and the accumulation of these in the crossbred organisms, they later utilize feed more efficiently, reproduce more intensely, develop better, and are more resistant to certain diseases and to current climate changes.

1. Birth weight plays an important role in any species for the subsequent development of organisms and their future performance capabilities. Therefore, understanding the prenatal factors that influence birth weight variation is of paramount importance for both health and viability during the neonatal period and in the long term [5,6]. In animal husbandry, knowing the external, controllable factors that influence live weight at various stages is important for agricultural economics [1].

Moreover, birth weight is an important indicator, as it reflects the development of the fetus during gestation and is considered a prenatal growth index. This has been studied intensively in an attempt to find mathematical terms that can later be used to optimize this indicator. Thus, as early as the 1960s, Stephenson and Lamborne, cited by Mochnacs et al. (1978) [7], concluded that to obtain accurate information regarding the maternal effect on the birth weight of lambs, research needs to be intensified both in the prenatal and postnatal periods.

In the research conducted, birth weight was determined within the first 2 days after lambing, during which the lambs were also individualized. The data were statistically processed and are presented in Table 1. Delaying the time at which lambs are weighed diminishes the accuracy of the data, as environmental influences become more pronounced and may cause considerable differences. Among all external factors, the mother's milk production most strongly influences changes in live weight during the early postpartum period.

The summary of values obtained from the statistical processing of data regarding the live birth weight of lambs shows that the average values fall within the biological limits of the species, and the absolute and relative differences are small and not statistically significant.

Table 1. The birth weight of lambs (kg)

Specification	n	Statistical indicators				
		$\overline{X} \pm s_{\bar{x}}$	s	V%	Minimum	Maximum
Ti	40	3.760±0.057	0.654	19.47	2.80	5.00
V x Ti	15	4.223±0.038	0.705	22.67	2.80	5.20
BMC x Ti	16	3.693±0.040	0.344	9.17	2.90	4.60
BC x Ti	15	4.066±0.117	0.470	16.73	2.98	3.80

V = Vandeen, BMC = Blanche du Masif Central, BC = Berrichon du Cher; Ti=brownȚigaie

At birth, the average live weight of lambs was higher in F1 crossbred lambs obtained from crossing Țigaie ewes with Berrichon du Cher and Vandeen rams. In both groups, the birth weight was over 4 kg. Compared to the group of lambs from the brown Țigaie breed (3.760±0.057 kg), the birth weight of the crossbred lambs resulting from crossing brown Țigaie ewes with Vandeen rams (4.223±0.038 kg) was 10.90% higher, while the birth weight of the F1 crossbred lambs from the Blanche du Masif Central cross (3.693±0.040 kg) was approximately 2% lower.

Although the values of this trait fall within wider variation limits, both the subsequent body development and the survival rate were not affected. This clarification is necessary because birth weight influences lamb mortality, as both

small, light lambs and large, heavy lambs are vulnerable and more susceptible to dying during the suckling period. Thus, achieving an optimal birth weight reduces the labor associated with difficult birth, lowers lamb mortality, and improves flock productivity. Recent studies by Keady et al. (2009), cited by Pascal (2019) [8], confirmed that in 15% of cases, neonatal lamb mortality (lambs that die within 7 days) occurs due to dystocia during birth, the most common cause being difficulties encountered during delivery.

The relationship between birth weight and survival is curvilinear, with more deaths occurring in lambs born with weights outside the ideal range of 4.0-6.0 kg [9], although the predominant causes differ between underweight and overweight lambs. Heavier lambs, especially singletons, have higher rates of dystocia and birth mortality, mainly due to fetal-pelvic disproportion [10].

On the other hand, lambs with low birth weight, especially those from ewes with multiple births, have a higher incidence of birth injuries but also die due to insufficient milk (starvation) and hypothermia [10, 11, 12].

2. Body weight of lambs at weaning age. To eliminate the influence of age on body weight expression, we decided to wean the lambs at the same age, specifically at 90 days.

The decision to wean the lambs at the specified age was imposed by traditional practices in our country regarding the weaning time of young sheep destined for fattening to produce meat.

In countries with a tradition in raising lambs for meat, the weaning time is often delayed significantly, often exceeding 100 days. Thus, Haresing, cited by Sandu [13], mentions that in England, lambs are weaned at ages over 4 months, or when the young sheep naturally separate from their mothers.

The average values obtained from the statistical processing of data specific to lamb body weights, determined at this point, highlight the good level of body development (Table 2).

The data analysis indicates that all average values are higher for the three groups of first-generation lambs. The highest body weights at 90 days were recorded in the VxTi and BMC X Ti groups. These two groups had higher live weights at weaning, by 11.17 kg and 11.295 kg, respectively, compared to the Țigaie breed lambs.

Table 2. Lamb weight at weaning (kg)

Specification	n	Statistical indicators				
		$\overline{X} \pm s_{\bar{x}}$	s	V%	Minim	Maxim
Ti	40	25.210±0.144	2.006	8.41	22.00	31.50
V x Ti	15	36.381±0.021	2.400	9.20	32.70	43.70
BMC x Ti	16	36.505±0. 421	2.611	9.31	31.90	44.40
BC x Ti	20	34.477±0.322	0.711	7.28	28.5	40.50

V = Vandeen, BMC = Blanche du Masif Central, BC = Berrichon du Cher; Ti=brown Țigaie

Table 3. Difference in weight at weaning (kg) and its statistical significance

Fisher Test	12.3404 ($\hat{F}$) >F 0.001; (2;006) 2.9100*** f.s.			
Tukey Test	Ti	V x Ti	BMC x Ti	BC x Ti
Ti	0	11.170***	11.295***	9.267***
V x Ti	-	0	0.124^{ns}	1.904^{ns}
BMC x Ti	-	-	0	2.028**
BC x Ti	-	-	-	0

V = Vandeen, BMC = Blanche du Masif Central, BC = Berrichon du Cher; Ti= brown Țigaie

In the case of the BCxTi crossbred group, the live weight recorded at weaning was only 9.267 kg higher. All these values confirm both the superiority of the crossbred lambs in terms of live weight accumulation and the fact that the local breed exhibits a high degree of genetic combinability with all three French meat breeds. Compared to data from the literature [1,14], we can affirm that our findings resemble with these facts, but we did not find precise references regarding the average body weight of young sheep recorded at the age of weaning when French meat breeds were used.

The statistical processing of the data shows that the difference between the live weight of Țigaie lambs and that of lambs from the three crossbred groups is very significant for $p \leq 0.001$. In contrast, the differences regarding the body weight of lambs recorded at weaning (Table 3) are not significant between VxTi and BMCxTi; the same significance was found between VxTi and BcxTi.

The analysis of the growth rate of lambs during the suckling period represents an objective assessment of the traits that contribute to live weight accumulation in young sheep at different stages of growth and body development. For lambs in the suckling period, meat production begins with the conversion of milk into weight gain, which is why, when considering the organization and production of sheep meat, the milk production of ewes should be an important criterion in nominating a breed to be included in a specific breeding scheme for the systematic production of meat lambs. Boccard, cited by Sandu [13], indicates that the maximum efficiency of converting milk into weight gain is about 0.200 l per kg gain for lambs that have a growth rate greater than 200 g/day.

However, establishing the requirement for 1 kg of gain is difficult because it heavily depends on the nature of body deposits, with different energy and protein levels, as the gain is constituted more from protein or more from fat.

Studies in this regard demonstrate that most often, intra- and inter-carcass fat deposits result from the energy remaining after satisfying all functions [8].

The average values determined from the processing of data related to the total gain accumulated during the suckling period and the average daily gain are presented in Table 4.

Table 4. Growth rate of lambs during the suckling period (kg)

Specification	n	Statistical indicators			
		Spor total (kg)		Spor mediu zilnic (g)	
		$\overline{X} \pm s_{\bar{x}}$	V%	$\overline{X} \pm s_{\bar{x}}$	V%
Ti	40	21.450±0.133	11.51	238.33±0.24	11.12
V x Ti	15	32.158±0.049	10.31	357.31±0.24	8.14
BMC x Ti	16	32.812±0.120	11.87	364.57±0.38	7.35
BC x Ti	20	30.411±0.055	9.09	337.90±0.22	7.79

V = Vandeen, BMC = Blanche du Masif Central, BC = Berrichon du Cher; Ti=brown Țigaie

In line with the data obtained for live weight determined at weaning, it is obvious that the average values of these indicators will also be higher for the groups of crossbred lambs. For total gain, while the Țigaie breed lambs accumulated an average total gain of 21.450±0.133 kg throughout the suckling period, the other three groups of F1 crossbred lambs had this indicator exceeding 30 kg. Practically, compared to the Țigaie lambs, the BCxTi crossbred group achieved a greater body mass accumulation of 8.961 kg, the BC x Ti group with 10.708 kg, while the largest

difference is found in the BC x Ti group, which at weaning had a total gain higher by 11.362 kg.

The analysis of specific average gain values confirms the superiority of crossbred lambs compared to those from the local breed. While the average accumulated gain up to weaning for Țigaie lambs was 238.33±0.24 g/day, all other three groups had values exceeding 300 g/day. In similar studies conducted on other sheep populations and under different experimental conditions, an average daily gain of 0.24±0.02 kg was obtained for Țigaie and Lacaune lambs during the entire lactation period, with values of 0.25±0.01 kg for females and 0.23±0.02 kg for males [15].

The evaluation of the heterosis effect was determined based on the performances of the groups subjected to research. Heterosis manifests as the superiority of the average performances of double, simple, or reciprocal hybrids compared to the parental generation [1]. The results obtained confirm the existence of differences between the groups for the observed heterosis (Table 5).

Table 5. The heterosis effect on weight gain indicators

Group of crossbred lambs	Traits	Average value at Ti	Average at crossbreeds in F1	Difference (heterozis)		Significance of difference
				real	$\frac{\overline{X}_{F1} - \overline{X}_P}{\overline{X}_P}$ x100	
V x Ti	ATG (kg)	21.45	32.15	10.70	33.28%	***
	ADG (kg)	238.33	357.31	118.98		
BMC x Ti	ATG (kg)	21.45	32.81	11.36	34.62%	***
	ADG (kg)	238.33	364.57	126.24		
BC x Ti	ATG (kg)	21.45	30.41	8.96	29.46%	***
	ADG (kg)	238.33	337.90	99.57		

ATG-average total gain; ADG-average daily gain; V = Vandeen, BMC = Blanche du Masif Central, BC = Berrichon du Cher; Ti=brown Țigaie; *** significant distinct (P ≤ 0.001).

In this stage of the research, the focus was on comparing the performances of all experimental groups for certain quantitative traits that allow for a real and objective analysis of the body development of lambs during the most sensitive period of their lives, which is the suckling phase. Based on the available data, it was decided to estimate the heterosis effect for total growth gain and average daily gain (Table 5), with plans to assess other traits in the subsequent phases.

The differences noted between the specific performance of the local breed and that of the crossbred lambs are obvious and statistically significant ($p \leq 0.001$). Furthermore, the fact that each variant of crossbred lambs surpasses the performance of the lambs from the maternal breed by approximately 30% for both parameters suggests that the paternal breeds were correctly selected, creating favorable conditions for achieving all objectives included in the experimental plan.

However, the large-scale expansion of crossbreeding faces two major challenges:

- It is a more difficult activity to organize with small herds.

-To increase the number of lambs fattened per mother from the F1 generation, where the fathers of these females come from a prolific breed but with poor meat production performance, which will have less predictable effects regarding growth rate and carcass quality of the fattened lambs, even if the terminal ram belongs to a breed specialized for meat.

CONCLUSIONS

The differences regarding the body weight of the lambs recorded at weaning are not significant between VxTi and BMCxTi; the same significance is observed between VxTi and BCxTi.

The differences obtained between the performance of the Tigaie breed lambs and that of the crossbred lambs are obvious and have a high level of statistical significance ($p \leq 0.001$) for both total gain and average daily gain.

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