Scientific Papers. Series D. Animal Science. Vol. LXV, No. 1, 2022
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

RESEARCH OF MORPHOPRODUCTIVE PERFORMANCE OF THE MEAT GOAT POPULATION COMPARED TO CARPATINA GOAT BREED

Corneliu-Ion NEACSU, Alexandru-Gabriel VARTIC*, Oana-Corina DORDESCU, Petru-Gabriel VICOVAN, Camelia-Zoia ZAMFIR

Research and Development Institute for Sheep and Goat Breeding Palas, 248 I. C. Bratianu Blvd, Constanta, Romania

*Corresponding author email: gabriel.alexandru88@gmail.com

Abstract

The ever-increasing requirements for goat meat production have led to create and consolidate a specialized goat population for meat production, well adapted to local environmental conditions, within the Research and Development Institute for Sheep and Goat Breeding - Palas. The new R1 population (75% Boer and 25% Carpatina) showed superior attributes compared to Carpatina breed. During the period of intensive fattening of the kids, the R1 males achieved an average daily gain of 152 grams compared to the group of males from the Carpatina breed, in which the increase was 119 grams/day. The R1 hybrids had 2.75 percentage points more muscle tissue in the carcass and 3.11 percentage points less bones than the Carpatina kids. The adult goats in the newly created population had a body compactness index with values between 84.26 and 94.31 and the muscularity index of the gigot had values of 245.58 - 249.01. In regards to our research was observed the superiority of R1 Boer x Carpatina goats compared to the Carpatina breed regarding to the meat production and the quality of carcass.

Key words*: carcass, goat, meat, Romania, yield.*

INTRODUCTION

The orientation and development of goat breeding in the direction of meat production is determined by the market demand for lean meat, while there are trends to implement a diet, limited in fats and especially in saturated lipids. In recent years there has been an increased interest for goat meat, which provides high biological value proteins and healthy fats due to a high ratio of unsaturated and saturated fatty acids to a low in cholesterol contents (Van Niekerk et al., 1988). It was found that this meat has a lower fat content by 50-65% compared to beef, by 42-59% compared to lamb and 25% lower compared to veal; also, the quality of the fat is better, respectively the content in saturated fatty acids is lower by 40% compared to chicken meat (without skin) and comparisons made with beef, pork or lamb meat emphasize that it has 85%, 100% and 90% less saturated fatty acids (Colomer-Rocher et al., 1987).

The objective of the research consisted in creating and consolidating a meat goat population well adapted to the environmental conditions in Romania, through crossing Boer and Carpatina breed, obtaining R1 goat population (75% Boer x 25% Carpatina) and selecting in the direction of increasing and improving meat production.

MATERIALS AND METHODS

The research was carried out on the new meat goat population and on the kids obtained at Research and Development Institute for Sheep and Goat Breeding Palas.

The main body dimensions were determined using the zoometer, compass and ribbon, calculating two conformation indices for goats and kids in the new population (Colomer-Rocher et al., 1987).

Breeding indices in mother goats (fertility, prolificacy, birth rate and survival of the kids until weaning) were determined compared to the values recorded by the goats Boer from South Africa, taken from the literature (Amoah et al., 1996; Crepaldi et al., 1999; Galina et al., 1995; Mellado et al., 2000).

Feed consumption was determined for weight gain in goats (subjected to intensive fattening for 120 days) R_1 Boer x Carpatina compared to Carpatina contemporaries, in which the growth performances were tested determining the

weight increase, the nutrient consumption and the quality of the resulting carcasses.
The combined feed used had an energy content of 2570 kcal / kg, 16% raw protein, 3.50% raw fat and 8.50% raw cellulose.
At the end of the fattening period, the control slaughters were performed (3 animals from each batch), the slaughter yield was calculated (yield 1 and yield 2), and the carcasses were assessed.
The yield at slaughter and the existing differences (with statistical significance) between the R_1 Boer x Carpatina and Carpatina kids were determined, subsequently determining the section areas of the muscle *Longissimus dorsi* and the thigh section in the middle of the femur, perpendicular to its longitudinal axis. Section areas were determined using the autoCAD program (Van Niekerk et al., 1988).
Carcass conformation indices, genotype differences and statistical significance were determined (Pascal, 2015; Taftă, 1996).
The slaughter yield was calculated as follows:

$$\text{Yield 1} = \frac{\text{Weight of cooled carcass (kg)}}{\text{Living weight (kg)}} \times 100$$

$$\text{Yield 2} = \frac{\text{Weight of cooled carcass (kg)}}{\text{Empty living weight (kg)}*} \times 100$$

* Empty living weight = live weight from which the contents of the digestive tract have been subtracted.

Each carcass was cooled for 24 hours at +2 - +4°C, after weighing, it was sectioned into 2 half carcasses. All determinations were made on the right half of the carcass, the division into different commercial regions was made according to the French cutting system.
The gigot was separated from the carcass by sectioning between the sacrum joint and the 6th lumbar vertebra (L6). The shoulder blade was detached from the thoracic muscle insertion.
The rest of the carcass was represented by: neck, with the bone base of the 7 vertebrae; thorax, with the bone base of the 13 ribs and the sternum; lumbar area, with the bone base of the 6 lumbar vertebrae, all dressed in the afferent muscles, in the carcasses was also included abdominal muscles.
After cutting the carcasses into the 3 pieces (gigot, shoulder blade, the rest of the carcass), each piece was dissected, separating the muscles, fat (covering - ribs and intermuscular) and bones. Each tissue was then weighed to the nearest ± 5 grams.
The caliper measured the large diameter and small diameter of the *Longissimus dorsi muscle,* as well as the thickness of the surface fat layer, calculating conformation indices (Compactness Index of the Gigot - C.I.G.***, Muscularity Index of the Gigot - M.I.G.****) and differences between genotypes with statistical significance (Lu et al., 1988; Rău, 1989; Sodiq et al., 2004).

$$*** \text{ C.I.G.} = \frac{\text{Width of coxofemural joints}}{\text{Length of gigot}} \times 100$$

$$**** \text{ M.I.G.} = \frac{\text{Perimeter of gigot}}{\text{Length of gigot}} \times 100$$

The tissue structure of carcasses was established in R_1 Boer x Carpatina kids compared to Carpatina kids and differences between genotypes, with statistical significance (Fisher Test).
Statistical data processing was performed by classical methods (Sandu, 1995).

RESULTS AND DISCUSSIONS

The main dimensions of goats were: a body length of 85.17 cm, the height at the withers and at the croup was 79.42 cm, the width at the shoulders 26.17 cm, the hip joint width 25.5 cm, rib width was 29.92 cm, chest depth 40.25 cm, the chest girth was 104.58 cm, the perimeter of the whistle was 12.25 cm, the perimeter of the hind leg was 73.42 cm and the length of the hind leg had an average value of 30.0 cm.
The goats had a trunk length of 70.67 cm, the height at the withers was equal to the height at the croup with a value of 68.67 cm, the width at the shoulders was 21.75 cm and at the hip joints it had an average value of 23.44 cm; the width at the ribs was 28.97 cm, the depth of the chest had an average value of 29.89 cm, the chest girth was 95.28 cm, the perimeter of the whistle was 10.69 cm, the perimeter of the hind leg was 61.33 cm and the length of the hind leg had an average value of 25.22 cm (Table 1).

Table 1. The main body dimensions of goats R_1 Boer x Carpatina by sex (cm)

No.	Category	Trunk length	Withers height	Croup height	Shoulder width	Hip joint width	Rib width	Chest depth	Chest girth	Whistle perimeter	Hind leg perimeter	Hind leg lenght
		$x \pm s_x$	$x \pm s_x$	$x \pm s_x$	$x \pm s_x$	$x \pm s_x$	$x \pm s_x$	$x \pm s_x$	$x \pm s_x$	$x \pm s_x$	$x \pm s_x$	$x \pm s_x$
1.	Bucks	85.17 ± 0.6945	79.42 ± 0.6793	79.42 ± 0.6793	26.17 ± 0.4410	25.50 ± 0.4523	29.92 ± 0.7732	40.25 ± 0.2500	104.58 ± 0.4840	12.25 ± 0.1306	73.42 ± 0.8390	30.0 ± 0.5222
2.	Goats	70.67 ± 0.5941	68.67 ± 0.6812	68.67 ± 0.6812	21.75 ± 0.4358	23.44 ± 0.3636	28.97 ± 0.5920	29.89 ± 0.3223	95.28 ± 1.3499	10.69 ± 0.2463	61.33 ± 1.3431	25.22 ± 0.6981

In goats, the compactness index of the gigot had the value of 84.26 and the muscularity index of the gigot was 245.58, the value being lower than goats by 10.65% in the first index and by 1.38% in the second index (Table 2).

The number of goats R_1 Boer x Carpatina at breeding was 102 heads, of which they were mated 99 and gave birth 98, obtaining 152 kids, from which 135 were weaned (88.81%) resulting 1.38 kids weaned/goat (Table 3).

Table 2. Conformity indices on live animal in goats R_1 Boer x Carpatina

No.	Category	Compactness index of the gigot (C.I.G.)	The muscularity index of the gigot (M.I.G.)	± Differences between goats and goats			
		$x \pm s_x$	$x \pm s_x$	C.I.G.		M.I.G.	
				MU	(%)	MU	(%)
1.	Bucks	84.26 ± 2.0343	245.58 ± 5.2409	- 10.05	- 10.65	- 3.43	- 1.38
2.	Goats	94.31 ± 3.1712	249.01 ± 1.0019				

Table 3. The result of mating in goats R_1 Boer x Carpatina, 2021 season

No.	The goat stud (head)	Goats mounted (head)	Giving birth goats (head)	Born kids (head)				Weaned kids		
				Total	Alive	Dead	Aborted	Total	%	On giving birth goat
1.	102	99	98	152	135	16	1	135	88.81	1.38

In the giving birth 2021 season, the R_1 Boer x Carpatina goats had a fecundity of 98.99%, a prolificity of 155.10% and a birth rate of 137.76% (Table 4).

The weight of the male R_1 kids (75% Boer, 25% Carpatina) at birth was 2.87 ± 0.1677 kg and of the kids 2.51 ± 0.0900 kg. At the time of weaning, the weight of the kids of both sexes was similar.

The average daily gain made by male kids during this period was 125.9 g, 7.9% higher than the female kids - 116.60 (Table 5).

Table 4. Breeding indices in goats R_1 Boer x Carpatina in giving birth 2021 season

No.	Fertility (%)	Prolificity (%)	Birth rate (%)
1.	98.99	155.10	137.76

Table 5. Body weight dynamics in kids from birth to weaning

No.	Sex	Body weight (kg/head)		Age at weaning (days)	Average daily gain (g/head)
		At birth	At weaning		
		$x \pm s_x$	$x \pm s_x$	$x \pm s_x$	$x \pm s_x$
1.	Males	2.87 ± 0.1967	16.91 ± 1.1843	113.80 ± 0.9638	125.90 ± 11.9819
2.	Females	2.51 ± 0.0900	16.14 ± 0.9599	116.40 ± 0.8327	116.60 ± 9.1119

In R_1 Boer x Carpatina kids, the average daily weight gain was 152 g compared to 119 g in the Carpatina, the difference of approximately 28% being statistically significant.

It is also observed that the R_1 Boer x Carpatina kids consumed to achieve 1 kg weight gain: 18095 Kcal, 1053 g digestible protein (DP) and 5790 g dry matter (DM) compared to contemporary Carpatina, who consumed 24138 Kcal, 1430.4 g DP and 7867.2 g DM, the differences between genotypes being 25%, 26.38% and 6.40% higher in the Carpatina than the R_1 Boer x Carpatina kids, being very statistically significant (Table 6).

Table 6. Consumption per kg gain in R_1 Boer x Carpatina kids compared to Carpatina

No.	Genotype	Average daily gain (g/head)	Consumption per kg gain		
			Metabolizable energy (Kcal)	Digestible protein (g)	Dry matter (g)
		$x \pm s_x$			
1.	R_1 Boer x Carpatina	152 ± 6.52	18095	1053	5790
2.	Carpatina breed	119 ± 6.05	24138	1430.4	7867.2

R1 Boer x Carpatina kids had a slaughter yield of Y_1 with a value of 50.46% compared to 44.48% in the Carpatina and the Y_2 yield was for Boer x Carpatina 57.67% compared to 51.38% in the Carpatina (Table 7).

Table 7. Slaughter yield in R_1 Boer x Carpatina goats compared to the Carpatina

No.	Genotype	Body weight (kg/head)	Cooled carcass weight (kg/head)	Empty lived weight carcass (kg/head)	Yield at slaughter Y_1	Yield at slaughter Y_2
		$x \pm s_x$	$x \pm s_x$	$x \pm s_x$	$x \pm s_x$	$x \pm s_x$
1.	R_1 Boer x Carpatina	39.40 ± 2.7221	18.19 ± 0.4130	34.88 ± 2.9127	50.46 ± 1.3262	57.67 ± 1.1159
2.	Carpatina breed	34.67 ± 2.4340	15.49 ± 1.7555	30.07 ± 2.8085	44.48 ± 2.8787	51.38 ± 2.1068

It should be remarked that in terms of Y_1, the difference between R_1 Boer x Carpatina and Carpatina breed was 5.98 percentage points and in Y_2 the difference between R_1 Boer x Carpatina and Carpatina breed was 6.29 percentage points, both differences being very statistically significant (Table 8).

Table 8. Differentiation of slaughter yield and significance of differences

No.	Genotype	Yield		± percentage points between R_1 Boer and Carpatina breed		The meaning	
		Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
1.	R_1 Boer x Carpatina	50.46	57.67	+ 5.98	+ 6.29	P <0.001 Very significant	P <0.001 Very significant
2.	Carpatina breed	44.48	51.38				

In the R_1 Boer x Carpatina kids, the area of the *Longissimus dorsi* muscle section was 12.06 cm^2 compared to 8.38 cm^2 in the Carpatina, the difference of 3.68 cm^2 (44.0%) being very statistically significant (Table 9).

Table 9. Area of the *Longissimus dorsi* muscle section in goats in the meat goat population compared to Carpatina contemporaries

No.	Genotype	The area of *Longissimus dorsi* muscle section (cm^2)	± Differences between R_1 Boer and Carpatina breed		
		$x \pm s_x$	cm^2	%	The meaning
1.	Meat goat population (R_1 Boer x Carpatina)	12.06 ± 0.7419	+ 3.68	+ 44.00	P <0.001 Very significant
2.	Carpatina breed	8.38 ± 1.0366			

The section area of thigh in the R_1 Boer x Carpatina kids had an average value of 103.95 cm^2 compared to 88.11 cm^2 in the Carpatina breed, the difference of 15.84 cm^2 (7.98%) in favor of the R_1 Boer x Carpatina kids, being very statistically significant (Table 10).

Table 10. Thigh section area (half of the femur perpendicular to its axis) in the new goat population compared to the Carpatina breed

No.	Genotype	Thigh section area (cm^2)	± Differences between R_1 Boer and Carpatina		
		$x \pm s_x$	cm^2	%	The meaning
1.	Population R_1 Boer x Carpatina	103.95 ± 5.5643	+15.84	+17.98	P <0.001 Very significant
2.	Carpatina breed	88.11 ± 1.4580			

Research has shown that in kids R_1 Boer x Carpatina, compactness index of the gigot (C.I.G.) had an average value of 85.47 compared to 53.60 in the Carpatina contemporaries and the muscularity index of the gigot (M.I.G.) had a value of 211.97 in the R_1 Boer x Carpatina and 131.16 in the Carpatina, the differences between R_1 Boer and Carpatina kids of 31.87 MU in the first index and 80.81 MU in the second being very statistically significant (P <0.001) - according to Table 11.

Table 11. Live animal conformation indices in R_1 Boer x Carpatina males compared to Carpatina contemporaries

No.	Genotype	Compactness index of the gigot (C.I.G.) *	The muscularity index of the gigot (M.I.G.) **	± Differences between genotypes and significance	
		$x \pm s_x$	$x \pm s_x$	C.I.G. (MU)	M.I.G. (MU)
1.	R_1 Boer x Carpatina	85.47 ± 1.5408	211.9 7 ± 6.0285	+ 31.87 P <0.001	+ 80.81 P <0.001
2.	Carpatina breed	56.60 ± 6.1748	131.16 ± 4.3824		

The compactness index of the gigot (C.I.G.) for R_1 Boer x Carpatina male kids had an average value of 83.43 compared to 50.07 for Carpatina male kids and the gigot muscularity index (M.I.G.) had a value of 201.79l for R_1 Boer x Carpatina kids and 106.16 in the Carpatina breed. The differences between the R_1 Boer x Carpatina and Carpatina breed genotypes of 33.36 MU in the first index and 95.63 MU in the second, being very statistically significant (Table 12).

Table 12. Male kids carcass conformation indices R_1 Boer x Carpatina compared to Carpatina contemporaries

No.	Genotype	Compactness index of the gigot (C.I.G.)	The muscularity index of the gigot (M.I.G.)	± Differences between genotypes and significance	
		$x \pm s_x$	$x \pm s_x$	C.I.G. (MU)	M.I.G. (MU)
1.	R_1 Boer x Carpatina	83.43 ± 2,0009	201.79 ± 1.1134	33.36 P <0.001	95.63 P <0.001
2.	Carpatina breed	50.07 ± 3.66668	106.16 ± 6.6836		

In the kids group of R_1 Boer x Carpatina, the half-carcass weighed 8.87 kg of which 5.57 kg muscle, 2.15 kg bone and 1.15 kg fat, while in the Carpatina kids carcass weighed an average of 7.46 kg of which 4.48 kg muscle, 2.04 kg bones and 0.94 kg fat (Table 13).

Table 13. The tissue structure of the carcass in according to genotype

No.	Genotype	Carcass weight (kg) of which:			
		Total	Muscle	Bones	Fat
		$x \pm s_x$	$x \pm s_x$	$x \pm s_x$	$x \pm s_x$
1.	R_1 Boer x Carpatina	8.87 ± 0.1660	5.57 ± 0.2142	2.15 ± 0.0115	1.15 ± 0.0573
2.	Carpatina breed	7.46 ± 0.7449	4.48 ± 0.5179	2.04 ± 0.1884	0.94 ± 0.0755

R_1 Boer x Carpatina kids have 2.75 percentage points more muscle in the carcass and 3.11 percentage points less bones compared to Carpatina kids, the differences being statistically significant ($p < 0.05$) (Table 14).

Table 14. Percentage tissue structure in carcasses

No.	Genotype	Carcass weight of which (%)				± Differences between genotypes (percentage points)		
		Total	Muscle	Bones	Fat	Muscle	Bones	Fat
1.	R_1 Boer x Carpatina	100.0	62.80	24.23	12.97	+ 2.75 P <0.05	- 3.11 P <0.05	+ 0.37 P <0.05
2.	Carpatina breed	100.0	60.05	27.34	12.60			

CONCLUSIONS

From research regarding the morpho-productive performances of the R1 goat population (75% Boer x 25% Carpatina) compared to the Carpatina breed, the following conclusions can be drawn:

The main body dimensions performed on the live animal showed higher values for bucks by 3.23 - 34.66% compared to goats.

Compactness index of the gigot and the muscularity index of the gigot had values of 84.26-94.31, respectively of 245.58-249.01, being lower for bucks by 10.65% and respectively by 1.38% compared to the goats.

Breeding index for R_1 goats had the following values: fecundity 98.99%, prolificacy 155.10%, birth rate 137.76%.

The average daily gain made by kids during the lactation period was 116.60-125.90 g, being 7.9% higher in males compared to females.

During the fattening period (120 days), the R_1 Boer x Carpatina kids made an average daily gain of 152 g, being by 28% higher compared to the Carpatina kids, in which the increase achieved was 119 g/day.

For one kg of live weight gain, the R_1 kids achieved a lower specific consumption by 25% Kcal, 26.38% DP and by 26% DS compared to the Carpatina contemporaries. Also, the efficiency of feed conversion in growth increase was higher by 15.2% in Boer x Carpatina.

The slaughter yield was 44.48 - 50.46 %, being 5.98 percentage points higher in the group of R_1 compared to the Carpatina goats, the differences being very significant ($P < 0.001$).

The area of the *Longissimus dorsi* muscle section was content between 8.38 cm^2 and 12.06 cm^2, being 44% higher in the R_1 kids (75% Boer x 25% Carpatina).

The area of the thigh section was 103.95 cm^2 for the group of R_1 and 88.11 cm^2 for the Carpatina breed, being larger for cross breeds by about 17.98%.

The conformation indices on the live animal, respectively the compactness index of the gigot and the muscularity index of the gigot, as well as the conformation indices of the carcass (the compactness and muscular indices of the gigot) presented superior values to the batch of R_1 compared to the group of Carpatina goats, the differences being very significant ($P < 0.001$).

The tissue composition of the carcass was defined by the following relative values: muscles 60.05 - 62.80%, bones 24.23 - 27.34%, fat 12.60 - 12.97%, R_1 Boer x Carpatina products with 2.75 percentage points more muscle tissue in the carcass and 3.11 percentage points less bone compared to Carpatina kids, the differences being significant ($P < 0.05$).

The data obtained reveal the superiority of the population of R_1 75% Boer x 25% Carpatina compared to the Carpatina breed in all morpho-

productive traits, reproduction indices, slaughter yield and carcass quality indices.

ACKNOWLEDGEMENTS

This research activity was carried out with the support of the Ministry of Agriculture and Rural Development and funded by the ADER 813 Project from 01.10.2019, project which is in progress.

REFERENCES

Amoah, E. A., Gelaye, S., Guthrie, P. Rexroad, C.E. Jr. (1996). Breeding season and aspects of reproduction of female goats, *Journal of Animal Science*, 74(4), 723-728.

Crepaldi, P., Corti, M., Cicogna, M. (1999). Factors affecting milk production and prolificacy of Alpine goats in Lombardy (Italy). *Small Ruminant Research*, 32(1), 83-88.

Colomer-Rocher, F., Morand-Fehr, P., Kirton, A. H. (1987). Standard methods and procedures for goat carcass evaluation, jointing and tissue separation. *Livestock Production Science*, 17, 149-159.

Galina, M. A., Silva, E., Morales, R., Lopez, B. (1995). Reproductive performance of Mexican dairy goats under various management systems. *Small Ruminant Research*, 18(3), 249-253.

Lu, C. D., Potchoiba, M. J. (1988). Milk feeding and weaning of goat kids - A review. *Small Ruminant Research*, 1(2), 105-112.

Mellado, M., Amaro, J. L., García, J. E., Lara, L. M. (2000). Factors Affecting Gestation Length in Goats and the Effect of Gestation Period on Kid Survival. *The Journal of Agricultural Science*, 135(1), 85–89.

Pascal, C. (2015). *Treaty for the Breeding of Sheep and Goats.* Iasi, RO: Ion Ionescu from Brad Publishing House.

Rău, V. (1989) - Research on establishing the main morpho-productive properties in a goat population in Mureș County. *Scientific Papers of ICPCOC Palas - Constanța*, VI, Bucharest.

Sandu, G. (1995). *Experimental models in animal science.* Bucharest, RO: Coral Sanivet Publishing House.

Sodiq, A., Tawfik, E. S. (2004). Productivity and Breeding Strategies of Sheep in Indonesia: A Review. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, 105(1),71-82.

Taftă, V. (1996). *Goat Production and Reproduction*. Bucharest, RO: Ceres Publishing House.

Van Niekerk, W. A., Casey, N. H. (1988). The Boer goat. II. Growth, nutrient requirements, carcass and meat quality, *Small Ruminant Research*, 1(4), 355-368.