

## QUALITY OF ABORIGENOUS KARACHAY GOAT MEAT UNDER DIFFERENT CONDITIONS

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Invited paper

**Abstract:** In this study, the influence of different conditions of keeping and feeding on meat productivity and meat quality of indigenous Karachai goats kept in different geographical regions of the Karachay-Cherkess Republic was assessed. The experiment involved three populations of Karachai goats: Group I was kept at an altitude of 500-600 meters above sea level, II - 900-1000, III - 1600-2000 meters above sea level. There were no significant differences in slaughter indicators ( $P \geq 0.05$ ). However, there was a tendency to a decrease in the pre-slaughter weight, the area of the muscle eye in carcasses obtained from goats of the foothill and mountain zones (on average by 5.15% and 5.55%), the meat content coefficient from the foothill zone (7.3%) and several a greater proportion of bones in the carcasses of goats in the foothill and mountain zones (on average by 3.9%). Morphological cutting of carcasses showed the predominance of muscle tissue over bone - 76.8% versus 23.2%. The data of microstructural analysis of the longest muscle of the back of Karachai goats showed a large number of muscle fibers (on average 404.5 pieces per 1 mm<sup>2</sup> with their small diameter (on average 26.3 microns). Based on the assessment, it is concluded that the higher the height above the level the sea of the animal habitat, the lower the meat productivity and the lower the fat content in the meat.

**Key words:** Goat, Goat meat, Meat quality, Chemical composition

### Introduction

Goats are one of the earliest domesticated ruminants. They are traditional sources of meat, milk, wool, fluff, sheepskin and other animal by-products. The

unique abilities of goats, such as unpretentiousness in keeping and feeding, the ability to adapt to almost any natural and climatic conditions of the environment have made them widespread. Due to the variety of products obtained from them, goats have become the main source of resources and an integral part of the culture of many peoples of the world.

Also, goats are the most diverse species of livestock with pronounced morphological and physiological characteristics. To date, there are over 576 goat breeds registered in the world (FAO, 2019). Most of the goats are native and perfectly adapted to breeding conditions. The exceptional ability of native goats to develop territories unsuitable for breeding other types of productive animals made them indispensable sources of milk and meat in mountainous, arid and inaccessible places with scarce vegetation.

In many developing countries, goat meat is an important food source. Despite the numerical importance of the livestock (807.6 million head worldwide), the consumption of goat meat (4.5 million tons) is low compared to the consumption of beef or poultry (FAO, 2019). Countries with developed goat breeding have developed their own culture of goat meat consumption. For example, in North America and in western India, the so-called "Sabrito meat" is used. As the locals themselves say: "All cabrito is a goat, but not all goat is cabrito." This is a kind of veal in the goat world. Animals are fed only milk until 4-6 weeks of age and then slaughtered (*Exotic Meat Market, 2021*). In Africa, the Middle East and the countries of South-West Asia, animals are killed for consumption at the age of 12-24 months with a carcass weight of 13-25 kg males, 11-20 kg females. Adult goat meat is prized in Africa and India (animals age 2-6 years, carcass weight 20-30 kg) (*Devendra and Owen, 1983*).

As reported by *Stanisz et al. (2009)* the main lovers of young goat meat, with an increased demand during the Christmas and Easter periods, are concentrated in Greece, Italy, France, Spain and Portugal.

In Russia, goat breeding is not of great interest, especially meat. However, in several regions of the North Caucasian and Southern Federal Districts, the population of local Karachai goats is widespread. These animals perfectly combine all the valuable qualities of goats, plus they have good immunity and resistance to some diseases. At the same time, despite the fact that in some regions in some seasons of the year rather extreme weather conditions occur, Karachai goats, thanks to their unique characteristics, help to maintain production and are the main source of animal protein in the diet of local residents.

The aim of the study was to study the effect of different conditions of keeping and feeding on meat productivity and meat quality of indigenous Karachai goats kept in different geographic regions of the Karachay-Cherkess Republic.

## Materials and Methods

The Animal Ethics Committee of the North Caucasus Federal Agrarian Center has approved the procedures outlined in this document. The studies were carried out in 2019-2020 on three groups of typical Karachai goats bred in different regions of the KChR. The research scheme is presented in Table 1. The conditions of keeping and feeding the animals were different depending on the group and the norms adopted in the farms.

**Table 1. Experimental Scheme**

Containment area	Height above sea level	Groups of animals		
		group number	quantity	quantity for slaughter
Prikubansky district	500-600 m	I	53	3
Zelenchuksky district	900-1000 m	II	33	3
Karachaevsky district	1600-2000 m	III	73	3

In November 2020, at the age of 8 months, 3 goats from each group were slaughtered.

The pre-slaughter live weight was determined by weighing the animals after 24-hour fasting with an accuracy of 0.1 kg. At the same time, access to water was limited 2-3 hours before slaughter. The slaughter was carried out through a transverse incision of the skin of the neck and by cutting the carotid artery and jugular vein. Immediately after gutting, the weight of the paired carcass was determined, after cooling at a temperature of 4 ° C for 24 hours, the weight of the cooled carcass was measured with an accuracy of 0.1 kg. Each carcass was divided into 2 longitudinal halves. Sampling of meat for research was carried out in pieces weighing at least 200 g from the incision, the area opposite the 4-5th cervical vertebrae, in the area of the shoulder blade, in the area of the thigh.

The varietal composition of the carcass was established on the basis of the cut of the carcass in accordance with GOST 7596-81. The morphological composition of the carcass was determined during deboning. The chemical composition of muscle tissue was determined by the average sample of the pulp of the carcass according to generally accepted methods, the mass fraction of moisture - according to GOST 9793-74, fat - according to GOST 23042-86, protein - according to the Kjeldahl method, ash - by burning a sample, meat pH - according to GOST R 51478-99, caloric content by calculation according to the formula of V.A. (1951). Histological assessment of meat was carried out in accordance with GOST 19496-93.

Statistical processing was carried out using Microsoft Excel 2016 (Microsoft, USA). Results were expressed as arithmetic mean  $\pm$  standard deviation (Mean  $\pm$  SD). To determine the statistical significance of the differences in the mean values, the Student's t-test was used under three conditions of probability "P" and different numbers of degrees of freedom.

## Results

It was found that, on average, for three populations of Karachai goats, carcasses obtained from young animals had a mass of 13.4 kg, after cooling - 13.1 kg; the yield of cuts of grades 1 and 2, pulp and bones, respectively, amounted to 81.1 and 18.9%; 76.8 and 23.2%. The most significant indicators of meat productivity are the slaughter yield, the coefficient of meat content and the area of the muscle eye, which were 44.76%, 3.31 and 12.24 cm<sup>2</sup>, respectively. These indicators characterize carcasses as typical carcasses obtained from small ruminants (Table 2).

**Table 2. Indicators of meat productivity of young goats in different breeding zones (8 months)**

Indicator	Breeding zone			Average
	flat-hilly	foothill	mountain	
Pre-slaughter weight, kg	33.5 $\pm$ 0.41	32.0 $\pm$ 0.34	31.5 $\pm$ 0.52	32.3 $\pm$ 0.30
Carcass weight, kg	13.8 $\pm$ 0.38	13.5 $\pm$ 0.44	13.0 $\pm$ 0.31	13.4 $\pm$ 0.29
Internal fat mass, kg	1.05 $\pm$ 0.09	1.10 $\pm$ 0.12	1.0 $\pm$ 0.11	1.05 $\pm$ 0.07
Slaughter weight, kg	14.85 $\pm$ 0.32	14.60 $\pm$ 0.24	14.00 $\pm$ 0.38	14.48 $\pm$ 0.22
Lethal output,%	44.3	45.6	44.4	44.76
Chilled carcass weight, kg	13.5 $\pm$ 0.31	13.2 $\pm$ 0.29	12.8 $\pm$ 0.39	13.16 $\pm$ 0.21
Muscular eye area, cm <sup>2</sup>	12.72 $\pm$ 0.21	12.11 $\pm$ 0.11	11.90 $\pm$ 0.26	12.24 $\pm$ 0.18
Output, %				
cuts of 1 grade	80.6	81.0	81.7	81.1
2 grade cuts	19.4	19.0	18.3	18.9
pulp	77.4	76.0	77.0	76.8
bones	22.6	24.0	23.0	23.2
Meat factor	3.42	3.17	3.34	3.31

Results are presented as mean  $\pm$  SD

Chemical analysis of the average sample of muscle tissue showed that the protein content was 19.6, fat - 9.7, dry matter - 30.3, ash - 1%, which characterizes meat as a product with a low fat content and allows it to be classified as a dietary category.

Comparison of the parameters of goat carcasses from different breeding

zones did not reveal significant differences. It should be noted a tendency for a decrease in the pre-slaughter weight, the area of the muscle eye in carcasses obtained from goats of the foothill and mountain zones (on average, by 5.15% and 5.55%), the meat content coefficient from the foothill zone (7.3%) and a slightly higher specific the weight of bones in the carcasses of goats in the foothill and mountain zones (on average by 3.9%). However, in general, this did not affect the slaughter yield, which was at the level of carcasses obtained from goats from the flat-hilly area (45.6 and 44.4 versus 44.3%, respectively).

No significant differences were found in the indicators of the chemical composition of meat. There was a slight decrease in the amount of fat and calorie content in carcasses obtained in the foothill and mountain zones, respectively by 0.7 and 1.5 abs. percent, 2.3 and 6.7%. The established low calorie content for the meat of experimental animals - 1703.9 kcal, testifies to the high modern consumer (dietary) properties of goat meat (for reference: the calorie content of 1 kg of broiler meat is 1800 kcal, turkeys - 1940 kcal, veal - 970 kcal) (Table 3).

**Table 3. Chemical composition of young goat meat in different breeding zones (8 months)**

Indicators	Breeding zone			Average
	flat-hilly	foothill	mountain	
Content,%				
Moisture	69.3±0.67	69.5±0.72	70.2±0.84	69.7±0.47
Dry matter	30.7±0.34	30.5±0.35	29.8±0.43	30.3±0.25
Fat	10.4±0.18	9.7±0.26	8.9±0.21	9.7±0.16
Ash	1.1±0.11	1.0±0.09	1.0±0.12	1.0±0.08
Squirrel	19.2±0.34	19.8±0.43	19.9±0.62	19.6±0.28
Caloric content of 1 kg of pulp, kcal	1754.2±2.55	1713.9±4.77	1643.6±3.63	1703.9±2.52

Results are presented as mean ± SD

Morphometric analysis at the histological level of the longest back muscle made it possible for the first time to determine in Karachai goats the number of muscle fibers per square millimeter, their diameter, the content of connective tissue, which, respectively, amounted to 404.5 pcs., 26.3 µm and 8.47% (Table 4).

**Table 4. Microstructural analysis of the longissimus dorsi muscle (m. Longissimus dorsi) of young goats in different breeding zones (8 months)**

Indicators	Breeding zone			Average
	flat-hilly	foothill	mountain	
Number of muscle fibers, pcs. per mm <sup>2</sup>	398.7	402.4	412.5	404.5
Muscle fiber diameter, µm	25.2	26.1	27.8	26.3
Marbling score, point	24.4	22.6	20.8	22.6
Connective tissue content,%	7.8	8.7	8.9	8.47

The assessment of "marbling", determined according to the original method developed by the staff of the All-Russian Research Institute of Sheep and Goat Breeding for Sheep and which is based on the registration and branching of fatty interfiber and interbeam inclusions made it possible to establish an assessment of 22.6 points out of 40.0 possible. Comparison of the obtained results with similar ones for sheep showed that goats per square millimeter have 5.39% more muscle fibers with their diameter smaller by 12.0%, which can be interpreted as a result indicating that goat meat is more tender. At the same time, due to the lower content of fat inclusions, goat meat received 8.1 points less marbling than sheep meat. However, it is possible for goats to develop their own scale for assessing "marbling" and this requires a much larger amount of experimental data and their correlation with the tasting assessment of goat and sheep meat.

## Discussion

In our research, we state that carcasses obtained from 8-month-old Karachai goats can be characterized as typical for small ruminants. However, *Sheridan et al. (2003a)* argues that, compared to sheep of the same age and sex, goat carcasses are smaller and have less covering fat. Differences in the quality of goat meat depend on its physical and chemical properties (*Webb et al., 2005*), biological factors such as age, sex and breed of the animal, and non-biological factors such as pre-slaughter stress, slaughter techniques, chilling and freezing of carcasses (*Leo et al., 2020*). The physiological state of a living animal and the biochemistry of postmortem processes in muscles, fat, and connective tissue also directly affect the taste of meat (*Mamontova, 2012*). Nutrition also influences the quality of meat through species-specific flavonoids from feed sources, because the taste of meat is due to the ratio of fatty acids and the ratio of muscle to fat. Thus, most researchers agree that determining the quality of meat is multifaceted and difficult.

The percentage ratio of pulp to bones obtained by us (76.8% versus 23.2%) with morphological cutting of the carcass with a large predominance of muscle tissue can be explained by the rather young age of the experimental animals. The same conclusion was reached by *Santos et al. (2008)* and *Stanisz et al. (2009)*. They state that the carcasses of young goats contain a high percentage of muscle mass and a low percentage of bone tissue, intramuscular and subcutaneous fat.

The data of microstructural analysis of the longest muscle of the back of Karachai goats indicate a large number of muscle fibers and their small diameter in comparison with sheep, which allows us to conclude that the meat of goats is more tender. However, *Webb et al. (2005)* believe that goat meat is less tender than sheep meat. At the same time, tenderness decreases with increasing age of

slaughter. The nature of the decrease in the tenderness of meat with age can be explained by the function of collagen in the body of the animal - the collagen molecule becomes less soluble due to covalent cross-links between collagen fibers. *Yarmand and Homayouni (2010)* in studies of microstructural analysis of muscle fibers of goats found that the fibers run parallel to each other, the collagen fibers surrounding the muscle fiber are fuzzy, the surfaces of myofibrils seem to be normal. At the same time, the authors do not give a conclusion about the relationship between the microstructural structure and the tenderness of meat and do not indicate the breed used.

A lower fat content as a result of chemical analysis of the meat of Karachai goats was found in animals from group III (highlands) compared to the rest. This can be explained by a more active motor ability, in connection with the conditions of detention and more scarce forage resources. Our hypothesis is confirmed by colleagues from Brazil who have carried out work on Brazilian native goats. They explain the changes in fat content in animals with an association with the balance between dietary energy and nutritional requirements of goats (*Lopes et al., 2014*).

## Conclusions

Different conditions of detention did not reveal large differences in the quality of meat and meat productivity of Karachai goats. Comparison of morphometric parameters of muscle tissue in animals from different breeding zones showed that the higher the height above sea level of the area of their content, the greater the number of muscle fibers per unit area, respectively, with a smaller diameter and less fat inclusions. It is possible to further study the quality of the meat of Karachai goats with a detailed analysis of the profile of fatty acids, which will make it possible to give a clearer characterization of the qualitative analysis of meat.

## Kvalitet mesa autohtone rase koza karačaj pod različitim uslovima

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## Rezime

U ovom istraživanju rađena je procena uticaj različitih uslova držanja i ishrane na mesnatost i kvalitet mesa autohtonih karačaj koza koje se drže u različitim geografskim regionima Karačajsko-čerkeške republike. U eksperiment su bile uključene tri populacije karačaj koza: I grupa je držana na 500-600 metara nadmorske visine, II grupa na 900-1000, III grupa na 1600-2000 metara nadmorske visine. Nije bilo značajnih razlika u klaničnim pokazateljima ( $P \geq 0,05$ ). Međutim, postojala je tendencija smanjenja težine pred klanje, površine mišića u trupovima dobijenih od koza iz zona podnožja planina i planinskih zona (u proseku za 5,15% i 5,55%), koeficijenta sadržaja mesa iz zona podnožja planina (7,3%) i nekoliko puta veći udeo kostiju u trupovima koza u zonama podnožja planina i planinskim zonama (u proseku za 3,9%). Morfološko rasecanje trupova pokazalo je prevagu mišićnog tkiva nad kostima - 76,8% naspram 23,2%. Podaci mikrostrukturne analize najdužeg mišića leđa karačaj koza pokazali su veliki broj mišićnih vlakana (u proseku 404,5 po 1 mm<sup>2</sup> sa njihovim malim prečnikom (u proseku 26,3 mikrona). Na osnovu procene zaključuje se da što je veća nadmorska visina životinjskog staništa, manja je produktivnost mesa i niži sadržaj masti u mesu.

**Ključne reči:** koza, kozje meso, kvalitet mesa, hemijski sastav

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