STUDY ON THE NUTRITIONAL QUALITY OF GOAT MEAT REARED IN FREE-RANGE SYSTEM

Gabriela Frunză[1], M. Pop[1]

[1]*University of Agricultural Sciences and Veterinary Medicine Iasi, Romania*

Abstract

The purpose of this research was the nutritional quality appreciation of goat meat reared in free-range system. Were collected different muscle groups (muscles Longissimus Dorsi, Triceps Brachi, Semimembranosus) and the main edible offal (heart, liver, kidneys) from 12 specimens of young goat, aged four months, indigenous Carpathian breed. It was determined the content of proteins, lipids, collagen and water using automatic analyzer Food Check (infrared spectrophotometer); the mineral substances were determined by calcination and the non-nitrogenous extractive substances and energy value were determined by calculation based on classic formulas. Analysis of results, including by gender, using statistical methods and analysis of variance (ANOVA) revealed insignificant differences for analyzed muscle groups (eg. for Longissimus dorsi muscle: 1.6% fat, 22.05% protein, 4.45% collagen, 1.19% crude ash and 76.15% water), while edible offal composition analysis indicated a higher proportion of fat and respectively lower protein and water (eg. to heart: 5,03% fat, 20.67% protein, 4.0% collagen, 1.15% crude ash and 73.13% water).

Key words: goat, meat, proteins, lipids, collagen

INTRODUCTION

Goat is the animal of developing countries where more than 95% of goat population are reared indicating their economics importance and adaptation in the different agro-ecological zones. Goat meat for longer time occupied a special place in the human diet for variety of reason including preference, prestige, religion, tradition and availability, in almost all the communities with favorable nutritional quality aspects [1]. The Easter holidays tradition in our country involves the acquisition by the majority of population, of a lamb or newer goat (because its' sensory quality of meat). The kid meat intensive fattening (6-7 months) is produced in small quantities in our country, but there is a seasonal consumption of meat of raw kids (very young, 40-70 days) or delayed milk kids (3-6 months), from calvings from winter [7]. Lean goat meat is low in fat and saturated fatty acids, but high in unsaturated fatty acids such as linoleic and oleic that has been shown to possess hypocholesteremic properties [2, 6]. Goat meat cuts have protein levels comparable to similarly prepared beef, lamb, and veal but have lower fat content [2]. In addition, the percentage of saturated fat in goat meat is lower than in chicken, beef, pork, or lamb [6, 2]. Considering its high nutritional value and its greater unsaturated to saturated fatty acid ratio, goat meat has the potential to improve the health of susceptible populations without taking meat products out of their daily diet. [5, 10, 6, 11]. Several studies have been conducted to compare chemical composition of sheep and goats at the same slaughter weight, age or under similar feeding management [10, 9, 11]. It has been found that, goat meat is characterized by low intramuscular fat and higher moisture content at comparable ages and slaughter weight [8, 5, 4]; detailed information of these parameters in goats in the tropics, especially from traditional production systems is missing [11]. Such information is required to help consumers to make an informed decision in purchasing meat [11, 8, 1].

The research purposes started from lack of information and the limited research on nutritional quality of goat meat and carcass composition from free-range production system.

*Corresponding author:
frunza.gabriela27@gmail.com
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MATERIAL AND METHOD

The biological material consists of 12 specimens of youth goat, aged four months from native Carpathian breed. Were collected different muscle groups (*Longissimus Dorsi muscles, Triceps Brachi, Semimembranosus*) and the main edible offal (heart, liver, kidneys).

It was determined the protein content, fat, collagen and water using automatic analyzer Food Check (infrared spectrometer); minerals were determined by calcination and non-nitrogenous extractive substances and energy value were determined by calculation based on classic formulas.

Analysis of the results was performed according to gender, using classical statistical methods and analysis of variance test ANOVA. To determine the nutritional value of goat meat, the conversion factors [3] for proteins was 4.27, for lipids was 9.02 and for non-nitrogenous extractive substances was 3.87 (by FAO, 2003).

RESULTS AND DISCUSSIONS

The chemical composition of goat meat is as follows: moisture 74.2–76.0%; protein 20.6–22.3%; fat 0.6–2.6%; ash 1.1% [6].

In the present study, the average values for *Longissimus dorsi* muscle was: 1.6% fat, 22.05% protein, 4.45% collagen, 1.19% crude ash and 76.15% water, while edible offal composition analysis indicated a higher proportion of fat and respectively lower protein and water (eg. to heart: 5,03% fat, 20.67% protein, 4.0% collagen, 1.15% crude ash and 73.13% water). These findings are in line with previous studies where goat meat is characterized by low intramuscular fat and higher moisture content. Shija et al., 2013, reported that goat meat contained little fat and therefore relatively higher proportions of protein and minerals. There are many factors, which can contribute to lack of agreement on effects of species on chemical composition between authors. These factors, which are often difficult to control between studies, include differences in maturity, breed, production systems, and feeding management of animals used in these studies.

The coefficient of variation calculated for *Longissimus dorsi* muscles (tab. 1) highlighted a very homogeneous population for all analyzed parameters, its value not exceeding the threshold of 10%. Applying the test for analysis of variance (ANOVA) between males and females, from statistic point of view insignificant differences were found at the level of *Longissimus dorsi* muscles.

Table1 Chemical composition of *Longissimus dorsi* muscles

Chemical components	Gender	$\overline{X} \pm S_{\overline{x}}$	S^2	S	CV%	Min.	Max.
Lipids%	Females	1.60±0.06	0.02	0.14	8.84	1.40	1.80
	Males	1.71±0.07	0.04	0.19	9.58	1.44	1.98
Proteins%	Females	22.02±0.07	0.05	0.23	1.06	21.60	22.30
	Males	22.17±0.15	0.10	0.32	1.46	21.60	22.50
Collagen%	Females	4.45±0.04	0.00	0.06	1.44	4.37	4.57
	Males	4.37±0.07	0.01	0.10	2.31	4.37	4.67
Water%	Females	76.12±0.06	0.23	0.48	0.65	74.10	75.40
	Males	75.28±0.24	0.25	0.50	0.67	74.10	75.40
Ash%	Females	1.20±0.02	0.00	0.02	1.89	1.11	1.17
	Males	1.19±0.01	0.00	0.03	2.18	1.13	1.19
Dry matter%	Females	23.88±0.06	0.23	0.48	1.93	24.60	25.90
	Males	24.72±0.24	0.25	0.50	1.95	24.60	25.90
OS%	Females	22.68±0.07	0.23	0.48	2.02	23.43	24.75
	Males	23.53±0.24	0.25	0.50	2.07	23.41	24.75
NnES%	Females	0.27±0.06	0.10	0.31	3.97	0.06	0.85
	Males	0.84±0.34	0.11	0.33	9.73	0.05	1.06
BE kcal/100g	Females	109.48±0.45	4.76	2.18	1.99	107.55	113.89
	Males	113.34±0.62	5.88	2.43	2.18	108.30	114.82

OS%= organic substances
NnES%= Non-nitrogenous Extractive Substances
BE kcal/100g= brute energy

The coefficient of variation calculated for *Semimembranosus* muscles (tab. 2) revealed a non-homogeneous population for NnES%, for both female and male, one relatively

homogeneous for males for lipid levels (11.58%) and for other parameters analyzed expressed a population very homogeneous, its value not exceeding the threshold of 10%. Applying, between males and females, the test of analysis of variance insignificant differences were found at the level of *Semimembranosus* muscles.

Table 2 Chemical composition of *Semimembranosus* muscles

Chemical components	Gender	$\overline{X} \pm S_{\overline{X}}$	S^2	S	CV%	Min.	Max.±
Lipids%	Females	1.61±0.06	0.04	0.19	0.08	1.44	1.98
	Males	1.67±0.08	0.04	0.19	11.58	1.44	1.98
Proteins%	Females	21.97±0.10	0.05	0.23	1.06	21.60	22.30
	Males	22.05±0.13	0.10	0.32	1.46	21.60	22.50
Collagen%	Females	4.47±0.03	0.00	0.06	1.44	4.37	4.57
	Males	4.50±0.04	0.01	0.10	2.31	4.37	4.67
Water%	Females	74.87±0.20	0.23	0.48	0.65	74.10	75.40
	Males	74.57±0.20	0.25	0.50	0.67	74.10	75.40
Ash%	Females	1.14±0.01	0.04	0.02	1.89	1.11	1.17
	Males	1.16±0.01	0.01	0.03	2.18	1.13	1.19
Dry matter%	Females	25.13±0.20	0.23	0.48	1.93	24.60	25.90
	Males	25.43±0.20	0.25	0.50	1.95	24.60	25.90
OS%	Females	23.99±0.20	0.23	0.48	2.02	23.43	24.75
	Males	24.27±0.21	0.25	0.50	2.07	23.41	24.75
NnES%	Females	0.42±0.13	0.10	0.31	73.97	0.06	0.85
	Males	0.56±0.14	0.11	0.33	59.73	0.05	1.06
BE kcal/100g	Females	109.87±0.89	4.76	2.18	1.99	107.55	113.89
	Males	111.34±0.99	5.88	2.43	2.18	108.30	114.82

OS%= organic substances
NnES%= Non-nitrogenous Extractive Substances
BE kcal/100g= brute energy

The coefficient of variation calculated for *Triceps Brachii* muscles (tab. 3) revealed a very homogeneous population for the majority of the parameters analyzed, with except for the calculated NnES% both females and males, where has highlighted inhomogeneous values. Applying the test for analysis of variance between males and females, insignificant differences were found at the level of *Triceps Brachii* muscles.

Table 3 Chemical composition of *Triceps Brachii* muscles

Chemical components	Gender	$\overline{X} \pm S_{\overline{X}}$	S^2	S	CV%	Min.	Max.
Lipids%	Females	1.53±0.04	0.01	0.10	6.74	1.40	1.70
	Males	1.60±0.07	0.03	0.18	8.18	1.40	1.90
Proteins%	Females	22.05±0.08	0.03	0.19	0.85	21.80	22.30
	Males	21.97±0.12	0.09	0.29	1.34	21.50	22.30
Collagen%	Females	4.51±0.03	0.05	0.06	1.41	4.41	4.59
	Males	4.50±0.03	0.02	0.07	1.78	4.31	4.65
Water%	Females	74.67±0.16	0.15	0.39	0.53	74.20	75.30
	Males	74.40±0.18	0.20	0.45	0.60	73.60	74.90
Ash%	Females	1.13±0.01	0.00	0.02	1.98	1.11	1.17
	Males	1.15±0.02	0.00	0.05	3.98	1.09	1.21
Dry matter%	Females	25.33±0.16	0.15	0.39	1.55	24.70	25.80
	Males	25.60±0.18	0.20	0.45	1.75	25.10	26.40
OS%	Females	24.21±0.16	0.16	0.40	1.64	23.57	24.69
	Males	24.45±0.19	0.22	0.47	1.92	23.97	25.31
NnES%	Females	0.62±0.13	0.10	0.32	51.20	0.07	0.99
	Males	0.88±0.17	0.18	0.42	47.70	0.41	1.61
BE kcal/100g	Females	110.39±0.76	3.47	1.86	1.69	107.74	112.63
	Males	111.64±0.92	5.06	2.25	2.02	108.73	115.03

OS%= organic substances
NnES%= Non-nitrogenous Extractive Substances
BE kcal/100g= brute energy

The calculated coefficient of variation for liver (tab. 4) expressed a very homogenous population with exception of dry matter and NnES were it was found heterogeneous populations.

The coefficient of variation calculated for kidney (tab. 5) revealed a relatively homogeneous population for males in lipid levels (13.94%) and non-homogeneous for females (50.30%) and males (46.37%) at the level of NnES.

Table 4 Chemical composition of *liver*

Chemical components	Gender	$\overline{X} \pm S_{\overline{X}}$	S^2	S	CV%	Min.	Max.
Lipids%	Females	3.53±0.09	0.05	0.22	6.11	3.20	3.80
	Males	3.64±0.09	0.04	0.21	5.80	3.45	3.96
Proteins%	Females	21.47±0.12	0.08	0.29	1.34	21.10	21.90
	Males	21.53±0.15	0.13	0.36	1.68	21.20	22.19
Collagen%	Females	4.27±0.10	0.06	0.24	5.64	3.95	4.60
	Males	4.31±0.14	0.12	0.35	8.15	3.87	4.89
Water%	Females	73.07±0.18	0.20	0.45	0.62	72.60	73.90
	Males	72.69±0.22	0.30	0.54	0.75	71.96	73.30
Ash%	Females	1.46±0.01	0.00	0.03	1.94	1.42	1.50
	Males	1.48±0.03	0.00	0.07	4.53	1.38	1.58
Dry matter%	Females	23.94±3.23	62.77	7.92	33.09	26.10	27.40
	Males	24.26±3.29	65.10	8.07	33.25	26.70	28.04
OS%	Females	25.47±0.18	0.19	0.44	1.72	24.68	25.96
	Males	25.83±0.22	0.30	0.54	2.11	25.32	26.55
NnES%	Females	0.47±0.09	0.05	0.23	47.55	0.28	0.90
	Males	0.65±0.08	0.04	0.19	29.47	0.44	0.98
BE kcal/100g	Females	125.37±1.15	7.96	2.82	2.25	120.47	128.28
	Males	127.32±1.28	9.85	3.14	2.46	124.24	131.32

OS%= organic substances
NnES%= Non-nitrogenous Extractive Substances
BE kcal/100g= brute energy

Table 5 Chemical composition of *kidney*

Chemical components	Gender	$\overline{X} \pm S_{\overline{X}}$	S^2	S	CV%	Min.	Max.±
Lipids%	Females	2.96±0.10	0.05	0.23	7.89	2.60	3.20
	Males	2.89±0.16	0.16	0.40	13.94	2.30	3.40
Proteins%	Females	21.70±0.11	0.07	0.26	1.20	21.40	22.10
	Males	21.77±0.19	0.21	0.45	2.09	21.30	22.60
Collagen%	Females	4.32±0.03	0.01	0.08	1.85	4.21	4.45
	Males	4.28±0.06	0.02	0.15	3.42	4.01	4.45
Water%	Females	73.85±0.24	0.33	0.58	0.78	73.20	74.80
	Males	73.57±0.30	0.53	0.73	0.99	72.20	74.20
Ash%	Females	1.11±0.01	0.00	0.02	1.94	1.08	1.14
	Males	1.13±0.03	0.00	0.07	5.91	1.05	1.25
Dry matter%	Females	26.15±0.24	0.33	0.58	2.21	25.20	26.80
	Males	26.43±0.30	0.53	0.73	2.76	25.80	27.80
OS%	Females	25.04±0.23	0.32	0.56	2.26	24.12	25.69
	Males	25.31±0.29	0.52	0.72	2.84	24.68	26.69
NnES%	Females	0.38±0.08	0.04	0.19	50.30	0.12	0.61
	Males	0.65±0.12	0.09	0.30	46.37	0.27	0.99
BE kcal/100g	Females	120.81±1.35	11.00	3.32	2.75	115.29	124.23
	Males	121.54±1.79	19.18	4.38	3.60	116.00	128.30

OS%= organic substances
NnES%= Non-nitrogenous Extractive Substances
BE kcal/100g= brute energy

The coefficient of variation calculated for heart (tab. 6) revealed a relatively homogeneous population for lipids coming from males (12.70%) and a high in-homogeneity at the level of NnES, for both females (69.40%) and males (108.96%).

And for the main edible offal (liver, kidney and heart), applying the test for analysis of variance (ANOVA) between males and females, insignificant differences were found.

Table 6 Chemical composition of *heart*

Chemical components	Gender	$\overline{X} \pm S_{\overline{x}}$	S^2	S	CV%	Min.	Max.
Lipids%	Females	5.03±0.15	0.14	0.37	7.40	4.50	5.50
	Males	4.96±0.26	0.40	0.63	12.70	4.03	5.80
Proteins%	Females	20.67±0.11	0.08	0.28	1.36	20.30	21.00
	Males	20.92±0.21	0.27	0.52	2.47	20.43	21.90
Collagen%	Females	4.00±0.05	0.02	0.13	3.24	3.80	4.15
	Males	4.04±0.09	0.05	0.21	5.31	3.68	4.29
Water%	Females	73.13±0.12	0.08	0.29	0.39	72.70	73.40
	Males	72.98±0.21	0.28	0.52	0.72	72.10	73.47
Ash%	Females	1.15±0.01	0.00	0.03	2.24	1.12	1.19
	Males	1.17±0.02	0.00	0.06	4.96	1.08	1.26
Dry matter%	Females	26.87±0.12	0.08	0.29	1.07	26.60	27.30
	Males	27.02±0.21	0.28	0.52	1.94	26.53	27.90
OS%	Females	25.71±0.12	0.09	0.30	1.16	25.44	26.18
	Males	25.86±0.21	0.26	0.51	1.96	25.37	26.64
NnES%	Females	0.39±0.11	0.08	0.27	69.40	0.13	0.88
	Males	0.37±0.16	0.16	0.40	108.96	0.02	0.92
BE kcal/100g	Females	135.18±1.32	10.46	3.23	2.39	132.71	139.51
	Males	135.46±1.72	17.81	4.22	3.12	129.94	140.78

OS%= organic substances
NnES%= Non-nitrogenous Extractive Substances
BE kcal/100g= brute energy

For the heart, the collagen content was lowest (4.00 ± 0.05 to 4.04 ± 0.09 for females and males) compared to kidneys, liver and the muscular groups analyzed (tab. 1-5).

Brute energy value calculated for the main edible offal (tab 4, tab 5, tab. 6, fig. 1) showed a slight increase nutritional value for the heart (135,18 kcal/100 g for females and 135.46 kcal/100g for males), liver (125.37 kcal/100g for females and 127.32 kcal/100 g for males), kidney (120.81 kcal/100 g for females and 121.54 kcal/100 g for males) and to muscular groups coming from kids can be seen lower values of the crude energy, attributed to lower fat content compared to the offal, on average this fits between 109.48 kcal/100g for LD muscles coming from females and 111.64 kcal/100g for TB muscles originated from males (tab. 1, tab. 3, fig. 1).

The result of present study is in line with study conducted by Shija et al. (2013), Arain et al. (2010), Madruga et al. (2006) who reported that slaughter age had significant effect on physical-chemical characteristics of meat. Particularly the ash content increased with advancing slaughter age. In another study, Arain et al. (2010), Pieniak- Lendzion et al. (2008) also reported the similar trend of increase in ash content and attributed it with slaughter age.

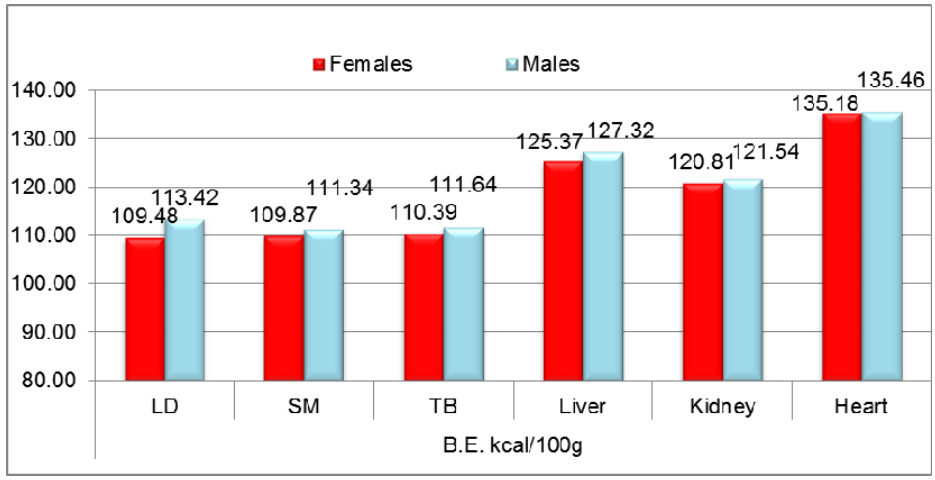

Fig. 1 Brute energy value for the main muscular groups and edible offal of kids

CONCLUSION

The goat meat it is appreciated at international level by consumers because its' nutritional value. Nutritional quality of goat meat from the Carpathian breed (kids) from free range system is given by the high content of protein (rich in essential amino acids), minerals (crude ash) and low content in lipids (low in cholesterol and rich in unsaturated fatty acids), being a dietetic meat with a low energy value (on average 122 kcal/100 g), similar from this point of view with the rabbit and hare meat. Between males and females, insignificant differences were found for all analyzed parameters (lipids, proteins, collagen, water, ash, dry matter etc.).

It will be useful to collect more data from the free-range production system of indigenous Carpathian breed goats for further understanding of meat quality attributes in comparison with modern breeds and production system.

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