

A REVIEW OF GOAT MEAT COMPOSITION, QUALITY AND HEALTH BENEFITS

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Abstract

With a long tradition in different regions of the world, rearing goats for meat production has become a valuable agricultural activity, given the adaptability of these animals to different environments and climatic conditions. Goat meat production plays a key role in meeting global demand for healthy meat. Although a major source of meat in developing countries, where it is valued, goat meat is less popular in Western countries. Perceptions are changing, however, as its health benefits are becoming increasingly recognized, mainly due to its low fat and cholesterol content. The aim of this article is to provide a detailed assessment of the composition and quality of goat meat, examining its nutritional aspects and impact on health, highlighting the benefits it can bring to the daily diet. Understanding these aspects is essential to ensure optimal quality for consumers, thus helping to promote goat meat as a valuable and healthy dietary option.

Key words: meat, goats, benefits, health

INTRODUCTION

Goats, considered as one of the most important species due to their unique characteristics and particular biological and economic significance, are widely distributed throughout the world and their breeding and farming industry is currently expanding significantly on a global scale, thereby playing a crucial role in the animal products sector [1].

The widespread of goats globally is largely due to the consistent production and high quality of their products, which have become essential in the various diet around the world because of their outstanding nutritional value [2].

At the same time, factors such as urbanization, rising living standards and increased interest in health and nutrition

have stimulated the expansion of the goat industry [3].

The growth of the global goat herd is driven by the expanding demand for products such as meat, milk and fiber, which are key contributors to the continuous and sustainable development and expansion of this sector [4].

In recent times, the goat farming sector has undergone significant changes worldwide, evidenced by the remarkable and rapid increase in herds on every continent [5].

In the last two decades, Asia has become the leader in the goat industry, with an expansion of over 43% of the world's total goat population [6].

China, India, Pakistan and Bangladesh have the largest number of goats in the global goat population, indicating the importance of goat breeding [7].

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In Europe, Romania is the fourth largest goat population, while Turkey has the largest goat population, followed by Spain and Greece [8].

Globally, raising goats for meat constitutes a key segment of the goat industry, having a major impact on meeting global demand for healthy meat [9]. Throughout history, in different regions of the world, this agricultural activity has gained significant value, benefiting from the versatility of goats in adapting to different climatic conditions and environments [10].

Global goat meat production in 2022 has been estimated to be around 19.1 million tons, highlighting its importance in the international food industry. In recent decades, this production has increased by 21.81%, reflecting a steady expansion in demand and production capacities [7].

This trend accentuates not only the value of goat meat as a source of protein, but also the adaptability of the goat farming industry to market demands and variability in environmental conditions [11].

Approximately 96% of the global goat population and 76% of goat breeds are found in developing countries in Asia and Africa [12].

In many parts of the world, meat is the main product and goat meat consumption is increasing worldwide [13]. Globally, goat meat consumption has increased compared to poultry meat [14].

However, goat meat is characterized by a low content of calories, total fat, saturated fat and cholesterol, while offering a unique flavor [15].

Factors influencing red meat consumption include cultural aspects, dietary habits, price, gender, socio-economic structure and religion [16].

Chemical composition of goat meat

Goat meat has considerable nutritional value, comparable to other red meats such

as beef, pork or lamb (Table 1). This characteristic is often valued for its health benefits due to its low fat, saturated fat and cholesterol content [17].

Goat carcasses are leaner than those of other species because the fat concentrates around the viscera and is removed during processing. This fat distribution contributes to the quality characteristics of goat meat, making it an attractive option for consumers [18].

Goat meat is unique in that it has a higher water than fat content, and the animals are not affected by serious diseases such as tuberculosis and brucellosis, which are common in cows [19].

Table 1. Nutrient composition of goat meat compared to other meat sources

Per 85 g of cooking	Goat	Chicken	Cow	Pork	Lamb
Calories (kcal)	122	162	179	180	175
Fats (g)	2.8	6.3	7.9	8.2	8.1
Saturated fats (g)	0.79	1.9	3.0	2.9	2.9
Proteines (g)	23	25	25	25	24
Cholesterol (mg)	63.8	76.0	73.1	73.2	78.2
Iron (mg)	3.2	1.5	2.9	2.7	1.4

Goat meat is distinctive for its reduced fat content, with 64% less fat than beef. Goat meat contains 55% less fat than chicken and 65% less than pork and lamb. Goat meat also has 53% less saturated fat than chicken and 73% less than beef, pork and lamb. Regarding cholesterol, goat meat has 16% less than chicken, 12% less than beef and pork, and 18% less than lamb [1].

Goat meat has a protein content comparable to that of beef, lamb and veal when similarly prepared. Goat meat can successfully replace other commonly consumed meats [20].

This similarity in protein composition emphasizes the nutritional value of goat meat, providing an essential protein source for a balanced diet [21].

Extensive research on goat meat indicates that, irrespective of breed, age or region, it provides high quality protein and healthy fats and is low in cholesterol [22]. In addition, goat meat is generally lower in fat and has a more favorable ratio of unsaturated to saturated fatty acids compared to beef and pork [23].

A study on the physico-chemical composition of goat and sheep meat patties made with different sources and proportions of fat (olive oil or pork belly) showed a reduced fat content (9.7-18.2%) compared to other similar meat products. The use of olive oil reduced the cholesterol level and increased the proportion of monosaturated and polyunsaturated fats, which may add nutritional value to goat and sheep products, contributing to their increased commercial acceptability [24].

In the literature, it is reported that intramuscular fat varies between 3.23% and 3.27% in beef, between 1.02% and 6.16% in sheep, while in goat meat this percentage is 2.27%. At the same time, goat meat stands out as the best protein source for cholesterol reduction [25].

The results of another study show significant differences in cholesterol levels between goat and sheep meat with values of 70.44 mg/100g and 75.53 mg/100g respectively [26].

In addition, goat meat is higher in iron and potassium than other meats. For example, goat meat contains 3.2 mg of iron per serving compared to beef (2.9 mg), pork (2.7 mg), lamb (1.4 mg) and chicken (1.5 mg) [27].

A comparative analysis between goat and sheep meat in one-year-old animals highlighted notable differences. Goat meat exhibited higher moisture levels and a lower fat percentage compared to lamb. Despite the fact that sheep had a higher slaughter yield, goat meat offered a leaner carcass with less than 3% fat content [27].

According to another study, goat meat has a significantly higher concentration of

sarcoplasmic proteins compared to lamb meat, while the concentration of myofibrillar proteins is similar in both species.

This characteristic, together with the low intramuscular fat content, makes goat meat a valuable source of protein that can contribute to a healthy and balanced diet [29].

Mineral content of goat meat

Goat meat, a lean red meat with dietetic properties, is distinguished by a darker shade of red, a coarser texture and a unique taste that is different from mutton. It is a rich source of essential amino acids and minerals such as potassium, zinc and iron [30].

Goat meat stands out for its rich content of essential minerals, crucial for maintaining the body's mineral balance [31]. (Table 2).

Overall, goat meat is a valuable source of essential minerals that support various biological functions, demonstrating its importance in a balanced diet.

Compared to other species, goat meat is distinguished by a higher content of potassium and phosphorus, two essential minerals that play crucial roles in maintaining optimal biological functions, including fluid balance and bone health. In addition, goat meat offers a favorable mineral ratio, with significantly higher levels of zinc, which are vital for strengthening the immune system and maintaining blood health [32].

Copper is crucial for hemoglobin formation and nervous system health, playing a key role in both animal well-being and meat quality.

Adequate copper intake helps prevent anemia, supports muscle function, and enhances the texture and nutritional value of goat meat. Additionally, copper contributes to the immune system's strength and is essential for maintaining proper enzyme activity in various metabolic processes, further improving overall meat quality [33].

Copper supplementation reduces the fat content in the meat, positively influencing texture by increasing stickiness and strength, while manganese contributes to

collagen synthesis, enhances tissue structure, and supports the integrity of the bone system.

Table 2. Mean mineral concentrations (mg/100 g) in muscle and organs

Minerals (mg/100g)	Muscle	Liver	Kidney	Heart	Spleen	Brain
Calcium	11	10,06	13,58	7,7	11,47	46,99
Phosphorus	155,5	253,9	168,1	111,71	214,03	245,64
Magnesium	19,7	15,08	10,19	9,63	15,28	12,82
Potassium	350	188,55	122,26	100,15	194,9	277,68
Sodium	64,48	58,18	148,68	38,52	59,38	136,92
Copper	0,30	8,28	0,52	0,53	0,41	0,40
Zinc	3,51	2,99	2,61	1,41	2,19	1,40
Iron	4,37	7,82	9,78	4,40	34,79	3,07
Manganese	0,087	0,66	0,19	0,098	0,159	0,122
Dry matter (%)	21,9	25,14	16,96	19,26	19,11	21,36

The average mineral concentrations (mg/100 g) in muscle and organs highlight the diversity of nutritional values provided by this animal. Phosphorus and calcium are well represented in liver and brain, reflecting their essential role in metabolic and neurological functions. Potassium is found in high amounts in muscle and brain, highlighting its importance in maintaining electrolyte balance and cardiovascular health [34].

In addition, goat meat is higher in iron and potassium than other meats. For example, goat meat contains 3.2 mg of iron per serving compared to beef (2.9 mg), pork (2.7 mg), lamb (1.4 mg) and chicken (1.5 mg) [27].

This variability in mineral distribution contributes differently to overall nutrient intake, providing unique benefits in the human diet. Dry matter content also varies between organs, influencing both nutrient density and the properties of each part.

Goat liver serves as an excellent source of essential minerals, particularly calcium and sodium, making it beneficial for individuals with deficiencies. Its rich calcium content supports bone health, while sodium is crucial for maintaining hydration

and nerve function. Incorporating goat liver into the diet can effectively address these mineral deficiencies and contribute to overall well-being [35].

The presence of lead at acceptable levels also confirms the safety of this product for consumption. These findings suggest that goat liver can contribute to balancing mineral intake in the diet without significant health risks. Goat liver contains higher levels of manganese (Mn), indicating its superior nutritional quality and making it a particularly beneficial source of this essential mineral for overall health [36].

These characteristics make goat meat an exceptional nutritional choice, providing a higher intake of essential minerals compared to beef, pork, chicken and turkey (Table 3) [34].

Compared to other meats, goat stands out for its high content of minerals that play a crucial role in the normal functioning of the body, such as potassium and iron. For example, goat provides a considerable amount of iron, more than most species, making goat meat a good source for preventing anemia and maintaining optimal energy levels in the body.

In addition, goat meat contains balanced levels of sodium and zinc, minerals essential for metabolic and immune functions. This nutritional balance makes goat meat a healthy option for those who want a nutrient-rich diet, while providing a lower sodium intake compared to other

protein sources, which can be beneficial for maintaining normal blood pressure.

Overall, goat meat not only matches, but in some aspects exceeds the mineral composition of other meats, making it an excellent choice for those looking for a healthy and varied source of protein and minerals in their diet.

Table 3. Average mineral content in meat of different species (mg/100g)

Minerals	Goat ¹	Shep ²	Cows ³	Turkey ⁴	Chicken ⁵
Calcium	11,0	5,7-9,6	3,4-18,8	1,7 - 20,3	6,1-23,0
Phosphorum	155,5	194-290	109-246	170-184	142-213
Magnesium	19,7	16,0-28,0	10,8-41,4	20-24	15,4-34
Potassium	350,0	291-365	141-380	261-271	179-667
Sodium	84,5	68,4-86,0	12-124	59-71	47-276
Copper	0,3	0,08-0,22	0,04-0,32	0,03-0,14	0,06-0,11
Zinc	3,5	1,7-4,5	2,9-4,8	0,6-3,0	0,1-2,3
Iron	4,4	0,6-3,3	0,7-3,5	04-1,7	0,4-5,6
Manganese (µg)	87,0	8,0-15,0	6,0-17,0		10-55
Selenium (µg)	-	2,7-14	6,0-17,0	3,4-1,7	5,8-16,4
Aluminium	-	-	-		1,2-3,9

Vitamin content of goat meat

Goat meat is a rich source of vitamins, especially B vitamins, which play a crucial role in energy metabolism and nervous system function (Table 4) [34].

Among these, vitamin B6 contributes about 20% of the daily requirement and vitamin B12 provides about 70% of the same requirement [37].

Goat meat is also rich in vitamins B1 (thiamine) (0.11 mg/100 g), B2 (riboflavin) (0.49 mg/100 g) and B12 (cyanocobalamin) (1.13 mg/100 g), all of which are vital for various metabolic processes in the body.

Goat meat has a higher riboflavin content than other types of meat, and all these vitamins are essential for protein and carbohydrate metabolism, fighting anemia [38].

These vitamins are essential for maintaining overall health, contributing to processes such as energy production, red blood cell formation and supporting cognitive functions.

The analysis of vitamin content in goat meat reveals significant diversity among breeds. For example, the Saanen breed is known for its high levels of riboflavin and vitamin B12, while the Alpine breed offers more vitamin A. Additionally, the Nubian breed is recognized for its rich vitamin E content. These variations emphasize the unique nutritional profiles specific to each breed, showcasing the overall nutritional richness of goat meat. For example, the Alpine breed has a higher vitamin B3 content (6.76±1.35 mg/100g) compared to the Saanen breed (5.20±1.04 mg/100g) and the Nubian breed (5.62±1.12 mg/100g).

Significant variations in the content of vitamins B5, B6, D3 and E were also observed between breeds, reflecting the complexity of the nutritional composition of the meat and implying the need for careful selection of breeds according to nutritional requirements and consumer preferences [39].

Table 4. Average vitamin content in meat of different species (mg/100g)

Vitamins	Goats ¹	Sheep ²	Cows ³	Turkey ⁴	Chicken ⁵
Thiamine (B1)	0,1	0,04-0,16	0,01-0,14	0,02 - 0,07	0,04-0,11
Riboflavin	0,56	0,05-0,27	0,08-0,22	0,06-0,2	0,03-0,19
Niacin	3,6	5,2-9,4	3,6-11,6	2,9-7,2	2,7-11,0
Pyridoxine (B6)	0,49	0,1-0,8	0,19-0,5	0,3-0,5	0,1-0,2
Folic Acid (µg)	-	-	7,9-15,0	7,0-10,0	2,6-4,0
Cyanocobalamin (B12) (µg)	1,13	1,0-3,3	1,0-2,5	0,38-0,42	0,2-0,38
Biotin (µg)	-	-	1,5-2,7	-	3,9-5,3
Pantothenic acid	-	0,7-1,3	0,3-0,4	0,6-1,0	0,8-0,9
Vitamin A (µg)	-	7,8-9,0	<5	5-6 (UI)	0,06-7,0
Beta-carotene (µg)	-	<5	10	-	-
Alpha-tocopherol (E)	-	0,2-0,5	0,6-3,6	0,02	0,3-2,2

Fatty acid composition of goat meat

Compared to other ruminants, goat meat is an excellent source of beneficial fatty acids due to the ability of goats to accumulate higher amounts of polyunsaturated fatty acids [40].

The fatty acid composition of goat meat is determined by a number of important factors, among which diet, breed and sex of the animals play a key role.

The diet of goats directly influences the type and proportion of fatty acids present in the meat, with visible effects on nutritional quality and health benefits (Table 5) [34].

The fatty acid composition of goat meat significantly influences its nutritional quality. Studies show that dry diet can increase the level of stearic acid in fat stores, contributing to a favorable

proportion of unsaturated fatty acids. Also, as animals grow, there is a decreasing trend in monosaturated fatty acids while saturated fatty acids increase.

These changes emphasize the importance of diet and rearing conditions on the fatty acid profile of goat meat [41].

In this context, it has been observed that feeding goats a blend of sea buckthorn and Russian olive produced an optimal fatty acid profile, highlighting the crucial role of diet in maximizing the nutritional value of goat meat [42].

It has been demonstrated that diet exerts a decisive influence on meat quality and fat composition in Murciano-Granadina kids, highlighting the significant impact of nutrition on these essential attributes.

Table 5. Mean fatty acid and cholesterol content in Longissimus dorsi muscle according to feeding mode (mg/100g muscle)

Fatty acids	On the pasture	Through the bushes	40% concentrated
16:0	296 ± 43,9	300 ± 35,7	474 ± 41,6
18:0	236 ± 36,5	261 ± 29,7	337 ± 34,6
18:1 trans-9	2,14 ± 1,13	5,09 ± 0,92	0,11 ± 1,07
18:1 cis-11	3,28 ± 6,57	37,0 ± 5,34	45,5 ± 6,22
18:1 cis-9	537 ± 90,14	571 ± 73,1	1010 ± 85,2
18:1 cis-7	18,9 ± 2,22	17,8 ± 1,80	27,5 ± 2,10
18:2 cis-10,12	6,25 ± 5,64	1,16 ± 4,58	10,8 ± 5,34
18:2 cis-9,12	65,0 ± 8,90	63,1 ± 7,23	83,5 ± 8,43
18:3 cis-9,12, 15	6,2 ± 1,13	16,7 ± 0,92	6,1 ± 1,07
18:2 cis-9, trans-11 CLA	11,6 ± 2,13	13,7 ± 1,73	11,8 ± 2,02
SFA	590 ± 86,2	621 ± 70,0	878 ± 81,6
MUFA	649 ± 104	692 ± 84,4	1,165 ± 98,3
PUFA	171 ± 9,37	180 ± 7,61	190 ± 8,87
n-6, n-3	6,83 ± 0,56	3,21 ± 0,46	8,75 ± 0,53
PUFA : SFA	0,34 ± 0,04	0,32 ± 0,03	0,23 ± 0,03
Total fatty acids	1443 ± 201	1520 ± 163,04	2,279 ± 190,03
Cholesterol	66,0 ± 2,39	61,0 ± 1,94	63,3 ± 2,26

It has been demonstrated that diet exerts a decisive influence on meat quality and fat composition in Murciano-Granadina kids, highlighting the significant impact of nutrition on these essential attributes. By comparing goat milk-fed and milk replacer-fed kids, the research revealed important changes in both the nutritional composition of the milk and the meat properties. Feeding milk replacer resulted in a substantial increase in the proportion of unsaturated fats, particularly oleic acid (C18:1), which had a positive impact on the overall nutritional value and sensory quality of the cooked meat. This dietary change improved the texture while also enhancing the taste and aroma of the meat. Additionally, variations in fatty acids such as C12:0, C15:0, C17:0, and C17:1 further highlighted the complexity of how diet can influence both nutritional aspects and organoleptic characteristics of meat in kids of this specific breed [43].

Goat meat PH

A key factor influencing meat quality is pH. In goats, deviations towards low pH (PSE) or high pH (DFD) are less common. Previous research has shown variations in pH values between different breeds of goats, but these seem to be related more to differences in the management of the animals before slaughter than to the breed itself.

For example, significant differences in pH values have been observed among goat breeds, even when the animals were managed under identical conditions and had the same weight [44].

In another study, slight differences in pH values correlated with carcass weight were observed. Heavier carcasses exhibited a lower pH, in contrast to less mature animals, which presented a higher pH. These differences suggest that the maturity and weight of the animal may influence meat composition and quality [44].

It has been shown that the pH of goat meat tends to increase with the age of the animals. Older animals exhibit better water holding capacity (WHC), which contributes to the juiciness of the meat. In contrast, cooking and drip losses are higher in younger animals, indicating lower meat quality. These findings emphasize the influence of age on the pH and quality of goat meat [45].

It is emphasized that pH plays a crucial role in the quality of goat meat, highlighting the significant impact of packaging methods and storage conditions on its sensory and nutritional characteristics. In meat packed aerobically, rapid microbial proliferation was observed, resulting in premature spoilage and reduced shelf life. In contrast, vacuum packing not only helps to maintain superior quality but also prolongs shelf life by inhibiting microbial growth. These findings underline the necessity for proper pH management and optimal storage conditions to ensure the freshness and overall quality of goat meat [46].

Goat meat is darker in color than other red meats, which is related to its higher pH and lower intermediate muscle fiber content. However, multiple studies highlight the significant influence of breed on meat color. Genotype plays a key role in determining muscle color and variations in redness intensity are often associated with the amount of heme pigment in the meat. This pigment concentration is influenced by factors such as species, age and muscle type, according to recent studies [47].

In recent years, numerous studies have made significant contributions to goat meat composition research, providing a thorough understanding of its nutritional values.

The cooking methods for goat meat significantly impact its aroma and quality. Grilling can lead to the loss of flavor compounds due to higher oxidation, while cooking at lower temperatures helps preserve the natural characteristics of the meat. These observations highlight the

importance of selecting the cooking method based on flavor preferences. These changes can affect the meat's protein content, fat composition, and overall flavor, providing insights into how cooking methods can enhance or alter the nutritional profile of goat meat [48].

Eating goat meat can help reduce blood vessel inflammation and stabilize heart rhythm.

Goat meat also contributes to lowering the risk of atherosclerosis and coronary

heart disease, due to its high content of unsaturated fatty acids, which play an important role in regulating blood cholesterol levels [49].

In addition, the unsaturated fatty acids in goat meat help to stabilize heart rhythm and maintain a healthy lipid profile, lowering LDL cholesterol and raising HDL cholesterol. This lipid balance is crucial for preventing common cardiovascular conditions that can lead to severe complications, including heart attacks and strokes.

Table 6. Chemical composition of goat meat at different stages

Nutritional components	Raw goat meat %	% RDA*	Cooked goat meat (per 100g)	% RDA*
Calories	109	5.5 %	143	7.2 %
Total fat	2.3 g	3 %	3 g	4 %
Saturated fats	0.7 g	3 %	0.9 g	4 %
Polyunsaturated fats	0.2 g		0.2 g	
Monosaturated fats	1 g		1.4 g	
Cholesterol	57 mg	19 %	75 mg	25 %
Sodium	82 mg	3 %	86 mg	3 %
Potassium	385 mg	11 %	405 mg	11 %
Protein	21 g	42 %	27 g	54 %
Vitamin A	0 %		0 %	
Calcium	1 %		1 %	
Vitamin D	0 %		0 %	
Vitamin B12	18 %		20 %	
Vitamin C	0 %		0 %	
Iron	15 %		20 %	

A comparative study evaluated the chemical composition of goat meat from the Saanen, Alpine, and Nubian breeds compared with lamb. The results showed that goat meat is about three times lower in fat and 3-5% higher in moisture than lamb. In particular, Nubian goat meat was distinguished by a significantly higher potassium content, more than 1.5 times higher than in Saanen and more than twice that of Alpine. The research also revealed notable concentrations of essential amino acids, covering between 14% and 30.5% of daily requirements [50].

CONCLUSIONS

Goat meat is characterized by a high protein content, good water retention and a brittle texture, which contributes to a pleasant eating experience. It is also of excellent microbiological quality, with no pathogenic bacteria, thus ensuring food safety. The low sodium content and favorable freshness values underline the quality of the meat.

With a low intramuscular fat content and a favorable ratio between unsaturated and saturated fatty acids, goat meat is a healthy option, contributing to a balanced diet. Therefore, its consumption can support a healthy and active lifestyle [51].

Goat farming makes a significant contribution to the global food industry with

a positive impact on the production of healthy meat. Goat meat is low in calories, fat, and cholesterol, making it a favorable nutritional option for consumers. As the demand for this meat continues to grow, promoting its nutritional benefits is essential in modern food trends.

Goat meat stands out for its superior nutritional value, being lower in fat, saturated fat, and cholesterol compared to other red meats. Due to the fat distribution, goat carcasses are leaner, providing an excellent source of high-quality protein. The mineral content, particularly iron and potassium, is also higher than in other species, making goat meat a healthy choice for consumers. This supports a balanced diet and helps reduce the risks associated with eating fatty meats.

In conclusion, the nutritional value of goat meat positively influences human health, as it has lower total fat and cholesterol content, as well as lower saturated fatty acids compared to other commonly consumed meats [52].

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