Comparative analysis of goat meat of different breeds in order to produce sausages for schoolchildren

Gulzhan Tokysheva[1], Kadyrzhan Makangali[1*], Rauan Mukhtarkhanova[2], Aknur Muldasheva[1],Saule Shukesheva[3], Madina Begaly[1]

[1] Department of Technology of Food and Processing Industries, Seifullin Kazakh Agrotechnical University, Astana, Kazakhstan, 010000
[2] Department of Science Management, Almaty technological university, Almaty, Kazakhstan, 050000
[3] Accredited Testing Laboratory of Food safety, Almaty Technological University, Almaty, Kazakhstan, 050012

ABSTRACT

Background: The importance of ensuring children's life and health through proper nutrition remains significant. An assessment of the chemical composition of experimental samples of goat meat (Zaanen, Alpine, Nubian) revealed no abnormal deviations, with all indicators falling within the accepted range for this type of animal muscle tissue. The mineral composition analysis demonstrated that goat meat is abundant in essential elements.

Methods: The research objects were the meat of goats aged 9-10 months, obtained from 3 breeds: Nubian, Zaanen and Alpine (m. L. dorsi, shoulder blade), grown in the breeding farm "Zerenda" located in Kazhymukan village, Tselinograd district, Akmola region, Kazakhstan. The meat was bought in a specialized meat market.
The moisture content of raw material samples was determined by drying in a drying cabinet at a temperature of 150 ± 3 °With the addition of sand, the drying process is carried out within 1 hour.

Result: The conducted studies have revealed significant differences in saturated fatty acids among the breeds. For instance, the Zaanen breed exhibited a share of 6.08% myristic acid, while the Nubian breed had 6.97% and the Alpine breed had the lowest share of myristic acid at 2.32%. The Zaanen breed also displayed the highest percentage of palmitic acid at 35.71%, compared to 26.18% and 26.06% in the Alpine and Nubian breeds, respectively. It is noteworthy that the Zaanen breed lacked C17 saturated and unsaturated fatty acids, namely margarine C17:0 and heptadecene C17:1. On the other hand, the Alpine and Nubian breeds had an average share ranging from 1.5% to 3.7% for these fatty acids. The Nubian breed exhibited the highest amount of stearic acid at 16.88%, whereas the Zaanen breed had the smallest amount at 12.93%. Physico-chemical analysis indicated that the studied samples of goat meat had a relatively low fat content while maintaining a higher moisture concentration, which is indicative of dietary raw materials. This type of raw material also possesses a high moisture binding capacity, making it a

potential ingredient for various meat products targeting schoolchildren, as it ensures a higher yield from a technological standpoint.

Key-words: Goat meat, Nutritional value, Nutrition of schoolchildren, Amino acid composition.

*Corresponding Email: **kadyr.makangali@gmail.com**
[1] Seifullin Kazakh Agrotechnical University

INTRODUCTION

Currently, the undisputed leader among meat raw materials is beef. In 2021, about 1,222.4 million tons of meat were produced in the Republic of Kazakhstan in total. A significant part falls on beef 879 million tons. In general, we can note the hegemony of beef. Along with this, it is possible to notice the trend of growth in the number of goats. In total, over the past 3 years, the total livestock showed an increase of more than 200 thousand heads. A number of studies characterize goat meat as a highly valuable raw material with great prospects for use in areas related to therapeutic and preventive nutrition (Tokysheva et al., 2022).

Goat meat is an unconventional raw material. At the same time, it is unfairly deprived of attention, since the main goal of goat breeding is associated with the widespread use of goat's milk for the production of various kinds of dairy products (Chauhan et al., 2021; Teixeira et al., 2021; Ivanović et al., 2020). At the same time, goat meat has a number of significant advantages over other types of red meat, such as: rich in amino acid, mineral composition, a large amount of unsaturated fats. At the same time, goat meat is easily digestible and hypoallergenic, which makes it possible to use this type of meat in the production of products for functional nutrition (Mahachi et al., 2020; Teixeira et al., 2020; Li S et al., 2022).

A group of scientists from Tanzania conducted a comparative analysis of raw meat obtained from male long-tailed sheep and East African goats. Individuals aged from 1.5 to 2 years were selected for the study. The live weight of the selected animals was between 22 and 50 kilograms of total meat studied from 34 animal carcasses (17 sheep and 17 goats). Muscle, fat and bone tissues were examined. A broad back muscle (longissimus dorsi muscle) was selected to assess the quality of meat. In terms of humidity, goat meat has a higher indicator (70.65%), while sheep meat (66.96%). According to the pH indicator, goat meat shows an indicator at the pH level of 5.88 mutton at a pH of 5.7. At the same time, mutton stands out with a more delicate structure than goat meat, the researchers explain this by the difference in the structure of muscle fibers. Researchers note significant differences between the studied types of meat by chemical composition (Shija et al., 2013).

The study examined the influence of the goat diet on the fatty acid profile and overall quality of the resulting meat. Twenty-four kid goats of the Kachagan breed, with an average live weight of 14.2 ± 1.46 kg, were selected for the experiment. One group of animals had palm oil added to their diet at a concentration of 3%, while the second group had a similar concentration of rapeseed oil added to their feed. Blood samples and animal weighing were conducted before the experiment, as well as after 33, 66, and 102 days. The results showed that the addition of 3% rapeseed oil to the goats' diet improved the fatty acid profile of the meat by increasing the concentration of omega-3 fatty acids, making it more beneficial for health. No similar effect was observed from palm oil (Karami et al., 2013).

Another study investigated subcutaneous fat in young goats aged 4, 6, and 8 months, focusing on Russian and Zaanen breeds. Valuable polyunsaturated fatty acids were found in significant amounts, with the optimal value observed in goats aged 6 months (Lushnikov, 2016; Jia et al., 2021).

Kazakhstan currently has approximately 180 million hectares of pasture lands, including 18.7 million hectares of foothill and 8.9 million hectares of mountain pastures. However, the utilization of pastures is relatively low at about 10-15%. Foothills and low mountains are considered optimal pastures for goats, and the low utilization of pastures presents an opportunity for large-scale goat breeding (Kenenbay et al., 2022).

The global goat meat market is developed asymmetrically, with it being a traditional meat raw material in countries in Asia and Africa, while considered a promising direction in many other continents. However, in recent years, goat meat has been gaining traction in the meat products market due to its composition features, which make it suitable for dietary, therapeutic, and preventive diets (Sujarwanta et al., 2021; Ivanovic et al., 2014).

According to the Food and Agriculture Organization (FAO), approximately 6.3 million tons of goat meat were produced worldwide in 2019. The largest production volume was in Asia (4.53 million tons), followed by Africa (1.47 million tons), America (137.41 thousand tons), Europe (96.3 thousand tons), and Oceania (22.6 thousand tons). The production of goat meat has shown consistent growth over the years, with a production volume of 2.7 million tons in 1991, increasing to 6.3 million tons in 2019 (GANIC et al., 2022).

As of 2019, the global goat population was approximately 1.1 billion heads, with the majority located in Africa (23.47%) and Asia (72.43%). These two regions account for more than 95% of the world's goat population.

The Asia and Oceania region represents one of the primary markets for goat meat consumption. In 2019, the total value of the goat meat market in foreign currency equivalent amounted to 30.1 billion US dollars, showing a 9.9% increase compared to 2018.

Goat meat is gaining popularity worldwide, as evidenced by economic indicators. While the current market capacity is relatively small, there is consistent growth in terms of meat volume and monetary value. Scientists are extensively studying the fundamental properties, composition, nutritional value, and potential for developing dietary and functional products based on goat meat.

The aim of the study is to study and substantiate goat meat for the production of children's sausages for the nutrition of schoolchildren. This will allow us to substantiate the beneficial properties of goat meat on the growing body of children.

MATERIALS AND METHODS

The research objects were the meat of goats aged 9-10 months, obtained from 3 breeds: Nubian, Zaanen and Alpine (m. L. dorsi, shoulder blade), grown in the breeding farm "Zerenda" located in Kazhymukan village, Tselinograd district, Akmola region, Kazakhstan. The meat was bought in a specialized meat market.

The moisture content of raw material samples was determined by drying in a drying cabinet at a temperature of 150 ± 3 °With the addition of sand, the drying process is carried out within 1 hour.

The fat content in the samples was measured using the Soxlet apparatus. This method involves multiple extractions of fat from the dried analyzed sample. The process entails placing the sample in a specialized glass chamber and repeatedly rinsing it with an organic solvent, typically petroleum ether or hexane. The solvent extracts the fat from the sample through continuous boiling and condensation, resulting in the separation of fat from other components. The collected fat is then weighed to determine its mass fraction or percentage in the sample.

The mass fraction of protein was determined using the Kjeldahl method. This method relies on the measurement of nitrogen content, as protein molecules contain nitrogen atoms. The analysis begins with the mineralization of organic substances in the sample by digestion with sulfuric acid. During this process, organic nitrogen compounds are converted into ammonium sulfate. The resulting mixture is then neutralized, and the ammonium ions are released. The liberated ammonium ions are then distilled, captured in a receiving solution, and titrated to determine their concentration. From this, the nitrogen content is calculated and used to estimate the protein content, assuming a specific nitrogen-to-protein conversion factor.

Both the Soxlet and Kjeldahl methods are widely employed analytical techniques for determining fat and protein content, respectively, in various food and agricultural samples.The ash content in the study samples is determined using a muffle furnace. The bowl with the test sample is placed in a muffle furnace and the temperature is brought to 550 ± 25 °C for 5-6 hours, until the formation of gray-white ash.

The calculation of the amino acid score involves comparing the content of essential amino acids in a protein source to the ideal amino acid composition established by the Food Committee of the World Health Organization (FAO/WHO). The ideal protein composition is defined as having specific amounts of essential amino acids per gram. According to the FAO/WHO amino acid scale, the ideal protein contains the following amounts (in milligrams) per gram of protein: isoleucine – 40, leucine – 70, lysine – 55, sulfur-containing compounds (phenylalanine + tyrosine) – 60, tryptophan – 10, and valine – 50.

To calculate the amino acid score for a particular protein source, the actual content of each essential amino acid is divided by the ideal content and multiplied by 100. The result represents the percentage of the ideal amino acid composition achieved by the protein source. Amino acid scores greater than 100% indicate that the protein source meets or exceeds the daily requirements for that specific amino acid. Scores lower than 100% indicate that the protein source is deficient in supplying the daily needs for that particular amino acid, making it a limiting amino acid.

By assessing the amino acid scores, it is possible to evaluate the nutritional quality of a protein source and identify any potential limitations in meeting essential amino acid requirements for human nutrition.Studies of the lipid fraction of meat were carried out by gas chromatographic method. The preparation of the samples consisted in the extraction of lipids from muscle tissue using a modified Folch method. To do this, meat in an amount of 5 g was homogenized with 50 ml of a mixture (1:1) of chloroform with methanol for 2 hours, a saturated aqueous solution of NaCl (1.0% by volume of the mixture) was added, then 5 ml of hexane was added to reextract fats. The fatty acids were analyzed using gas chromatography, following a modified version of the ISO 5509-1978 method. The procedure involved several steps: Preparation of the sample: A solution containing 10 mg of lipids in a mixture of 3 ml of a 15% acetyl chloride solution in methanol was prepared. Boiling and neutralization: The solution was heated to 100°C and boiled for 2 hours. After boiling, the reaction mixture was neutralized by

adding 1.25 ml of a saturated KOH solution in CH3OH to achieve a pH of 5.0-6.0. Extraction: To extract the fatty acid methyl esters, 3 ml of a saturated aqueous NaCl solution and 3 ml of hexane were added to the mixture. The solution was mixed, allowed to stand for 30 minutes, and then a 0.2 ml sample was taken from the transparent hexane layer. Gas chromatography analysis: The methyl esters of fatty acids were analyzed using an Agilent 7890 gas chromatograph equipped with a flame ionization detector and a capillary column (HP-Innowax 60mx0.32mmx0.5µm). The analysis was performed with a temperature gradient ranging from 100 to 260°C at a rate of 10°C per minute. The injection volume was 1 µl, and the gas flow was mixed at a ratio of 1:100. The detector temperature was maintained between 250 to 300°C. Calibration and quantification: A standard mixture of methyl esters of fatty acids (Supelco No. 47885U) was used for calibration. The gas chromatograph automatically calculated the data on the content of fatty acids ranging from C6 to C24. The quantitative content of fatty acids in the sample was determined using the method of internal normalization. Statistical processing of the results was performed based on the metrological characteristics stated in the methods used. In the absence of such characteristics, the principles outlined in accordance with clause 5.5 of the RMG 76-2014 were applied. The critical significance level of the null statistical hypothesis (p) was assumed to be 0.05.

RESULTS AND DISCUSSION

Meat products are indeed known for being natural sources of proteins and fats. Proteins in meat are essential for building and repairing tissues, supporting immune function, and providing energy. Fats, on the other hand, serve as a concentrated source of energy and are important for various bodily functions, including hormone production and nutrient absorption. By analyzing the physico-chemical parameters of goat meat, such as moisture, fat, protein, and ash content, we can gain insights into its composition and nutritional profile. These parameters can help determine the meat's overall quality, nutritional value, and potential health benefits. In addition to proteins and fats, goat meat also contains essential vitamins and minerals, such as iron, zinc, and B vitamins. These nutrients are important for maintaining overall health and well-being. Evaluating the physico-chemical parameters of meat is just one aspect of assessing its biological and nutritional value. Other factors, such as the fatty acid profile, amino acid composition, and presence of bioactive compounds, also contribute to understanding the nutritional value and potential health benefits of goat meat. There were such basic indicators as the mass fraction of moisture, fat, protein and ash. Data on the results of the study of physico-chemical parameters are given in Table 1.

These physico-chemical parameters provide insights into the composition of the different types of meat. Goat meats generally have lower fat content and higher protein content compared to mutton. The moisture content can vary slightly between the different types of goat meat. The ash content represents the mineral content in the meat and shows some variation among the different types.

Indeed, the presence of vitamins in meat is an important aspect of its nutritional value. Vitamins are essential organic compounds that play vital roles in various physiological processes within the human body. Goat meat contains a range of water-soluble and fat-soluble vitamins, each with its specific functions and benefits. Water-soluble vitamins, such as vitamin B3 (niacin), vitamin B5 (pantothenic acid), and vitamin B6 (pyridoxine), are important for energy

metabolism, nerve function, and the synthesis of important molecules in the body. These vitamins are not stored in large amounts in the body and need to be regularly replenished through the diet. The concentrations of these water-soluble vitamins can vary depending on the specific analysis conducted on the goat meat samples. Fat-soluble vitamins, including vitamin E and vitamin D, are present in goat meat as well. Vitamin E is a powerful antioxidant that helps protect cells from oxidative damage. Vitamin D plays a crucial role in calcium absorption and bone health, as well as supporting immune function. The concentrations of these fat-soluble vitamins in goat meat can also vary based on the analysis conducted. By determining the concentrations of water-soluble and fat-soluble vitamins in goat meat, we can assess its nutritional value and its potential contribution to meeting the recommended daily intake of these essential vitamins. Including goat meat in the diet can provide a natural source of vitamins, complementing the overall nutrient profile of a balanced and varied diet. Data on the results of the study are shown in Table 2.

The mineral composition of goat meat plays a significant role in its nutritional value. Minerals are essential for various physiological functions in the human body, including the formation of bones, regulation of fluid balance, nerve function, and enzyme activity. The composition of goat meat has been found to contain several minerals necessary for human health. Potassium and sodium are two prominent minerals in goat meat. Potassium is essential for maintaining proper heart function, muscle contraction, and nerve transmission. The Nubian breed of goat meat exhibited the highest potassium content (4125.83 ± 618.87 mg/kg) among the experimental samples, surpassing both the Zaanen breed (2470.10 ± 370.52 mg/kg) and the Alpine breed (1693.22 ± 253.98 mg/kg). Sodium, another important mineral involved in fluid balance and nerve signaling, also showed a higher concentration in Nubian goat meat (1518.21 ± 242.91 mg/kg) compared to the Zaanen breed (852.27 ± 136.36 mg/kg) and Alpine breed (1005.83 ± 160.93 mg/kg). Magnesium is another mineral present in goat meat that plays a crucial role in bone health, energy metabolism, and nerve function. The Nubian breed exhibited a higher concentration of magnesium (2955.88 ± 44.38 mg/kg) compared to the other breeds analyzed. The amino acid composition of goat meat is another important aspect that determines its biological value and protein quality. Meat and meat products are known for their high protein content, making them valuable sources of amino acids. Amino acids are the building blocks of proteins, and the balance between essential and non-essential amino acids is crucial for human nutrition. The specific results of the amino acid composition analysis of goat meat were not provided, but it can be inferred that the composition of amino acids in goat meat contributes to its overall protein quality and nutritional value. Analyzing the mineral composition and amino acid profile of goat meat allows for a comprehensive understanding of its biological and nutritional value, aiding in the assessment of its suitability as a protein source in the human diet. The data obtained during the study are shown in figure 1.

The amino acid score is an important indicator used to assess the nutritional quality of proteins and their ability to meet human requirements for essential amino acids. It compares the amino acid composition of a protein source to that of an "ideal" protein that provides the optimal balance of essential amino acids. The essential amino acids are those that the human body cannot synthesize and must be obtained from the diet. The amino acid score evaluates how well a protein source provides these essential amino acids relative to the ideal protein. A score of 100% or higher indicates that the protein source meets or exceeds the requirements for essential amino acids, while a score below 100% suggests a deficiency in one or more essential amino acids. To

calculate the amino acid score, the content of each essential amino acid in the protein source is compared to the recommended levels established by organizations such as the Food and Agriculture Organization (FAO) and the World Health Organization (WHO). These recommended levels are based on the needs of healthy individuals. The amino acid score is calculated as the ratio of the amount of each essential amino acid in the protein source to the amount of that amino acid in the ideal protein, multiplied by 100. The scores for all essential amino acids are then averaged to obtain the overall amino acid score for the protein source. Amino acid scores greater than 100% indicate that the protein source provides sufficient amounts of essential amino acids to meet human requirements. Scores below 100% suggest that the protein source may be lacking in certain essential amino acids and may need to be complemented with other protein sources to achieve a balanced amino acid profile. The amino acid score is a valuable tool in assessing the nutritional quality of proteins and can help guide dietary choices to ensure an adequate intake of essential amino acids. Data on the amino acid score are given in fig. 2.

The data presented in Figure 2 indicate that the studied samples of goat meat are indeed rich in essential amino acids. These amino acids play a crucial role in various physiological processes in the human body and must be obtained through the diet. For example, the Nubian breed of goat meat can cover 36.1% of the daily requirement for threonine per 100 grams, while the Alpine and Zaanen breeds cover 27.8% and 33.7%, respectively. The amino acid valine, which is also essential, is present in concentrations that can cover 25.6% (Alpine and Zaanen) to 33.8% (Nubian) of the daily needs. The studied samples of goat meat contain significant amounts of other essential amino acids as well. The concentrations of tryptophan, leucine, isoleucine, phenylalanine, and methionine in the samples can cover approximately 14% to 30.5% of the daily requirements. It is noteworthy that all the samples analyzed are particularly rich in lysine, an essential amino acid that is important for protein synthesis and various metabolic functions. The Zaanen breed of goat meat stands out as the leader in lysine content, covering 39.5% of the daily requirement. The Alpine and Nubian breeds also provide substantial amounts of lysine, covering 35.8% and 31.1% of the daily needs, respectively. Overall, the findings suggest that goat meat, regardless of the breed, is a valuable source of essential amino acids. Including goat meat in the diet can contribute to meeting the daily requirements for these essential nutrients.Laboratory studies have been conducted on the content of fatty acids in goat meat. Laboratory data are shown in fig. 3.

As can be seen from the results of the study, saturated fatty acids such as capric, lauric, myristic, myristoleic, palmitic, margarine, stearic and arachidonic were found in goat meat. Also, in the composition of goat meat, you can see the presence of a number of monounsaturated fatty acids. In particular, the concentration of oleic acid in all the samples studied is over 37%. The presence of fatty acids in the meat makes it possible to qualify goat meat as a valuable source with high nutritional properties.

Also, we investigated the moisture-binding indicators of meat raw materials (Fig. 4).

The moisture-retaining capacity of goat meat was not significantly different among the samples. This indicates that the selected fattening technologies and the absence of stress during the experiment contributed to favorable moisture-binding properties of the meat. Moisture-retaining capacity is an important quality parameter that reflects the ability of meat to retain its moisture content during cooking or processing. Higher moisture-retaining capacity results in juicier and more tender meat. In this case, the absence of significant differences suggests that the

selected fattening technologies and the proper maintenance and slaughter of the animals played a role in preserving the moisture content of the meat. Additionally, it is worth noting that the moisture-retaining capacity indicator in this study was not affected by stress, as it remained above the threshold value of 65%. Overall, these results suggest that the studied goat meat samples exhibited good moisture-binding properties, which can contribute to the overall quality and sensory characteristics of the meat.

The comparative analysis of goat meat samples and lamb meat reveals some differences in their nutritional composition, specifically regarding fat content, moisture content, and protein content. The fat content in goat meat is reported to be more than three times less than that of lamb meat. This lower fat content makes goat meat a leaner option compared to lamb. Lower fat content is often associated with lower calorie content and reduced risk of certain health conditions such as cardiovascular diseases. Consequently, goat meat can be considered a more dietary meat raw material in comparison to lamb. Furthermore, the moisture content in goat meat is reported to be higher than that of lamb by 3-5%. Higher moisture content contributes to the tenderness and juiciness of the meat, enhancing its palatability. The higher moisture content in goat meat further supports its potential as a dietary option. Regarding protein content, the differences between goat meat and lamb meat are relatively small, ranging from 1-3%. Both meats provide a significant source of protein, which is essential for various physiological functions and muscle growth and repair. Taken together, the comparatively lower fat content, higher moisture content, and similar protein content of goat meat make it a more dietary meat option compared to lamb. These characteristics also make goat meat a potential raw material for the development of functional food products that cater to specific dietary and nutritional needs.First of all, it is necessary to allocate a rich mineral and vitamin composition. These types of compounds are of great importance in the human diet due to the fact that they are not synthesized in the body and can only be obtained from outside. In all three studied vitamins of group B (B3, B5. B6) characteristic of raw materials of animal origin are widely represented, in addition to which the presence of fat-soluble vitamin E has been proven experimentally.

The composition of amino acids and the indicator of amino acid score is of great value for meat raw materials. Being basically a protein-based food. A significant amount of essential amino acids favorably allocates goat meat. The studied samples have shown their high value as a source of essential amino acids. For the interpretations of which the amino acid score was calculated.

To sum up, goat meat is a very valuable meat raw material with a potentially wide range of applications in the meat industry, especially for functional products, namely baby and gerodietic nutrition. The development of new products based on goat meat can significantly raise the level of health of the nation.

CONCLUSION

Physico-chemical analysis showed that the studied samples of goat meat as a whole have a low level of fat content and, at the same time, a relatively high concentration of moisture as an indicator of dietary raw materials. A high moisture binding capacity index also characterizes this type of raw material as a potential ingredient for a number of meat products and a subsequent high yield. The mass fraction of fat is many times lower than in widely consumed raw materials.

The calculated amino acid score of three different breeds of domestic goats showed that the amino acid leucine was determined as the limiting amino acid in all three objects of the ball study. It is worth noting that the amino acids of leucine in the Nubian breed are 1.2 times lower compared to the Zaanen and Alpine breeds.

Despite the difference in individual saturated fatty acids, it is important to note that the amount of saturated fatty acids for the Zaanen and Nubian breeds is almost the same – 55.1 and 54.91%, respectively, while the amount of saturated fatty acids in the Alpine breed was 46.68%, which makes the meat of this breed more valuable in terms of assimilation in the process digestion in humans. It is also very important to note the content of omega-3 fatty acids. No omega-3 fatty acids were found in the Zaanen breed, while for the Alpine and Nubian breeds their amount was 0.37% and 0.47%, respectively, which makes their fat more valuable in terms of biological value.

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CONFLICT OF INTEREST

The author(s) declares no conflict of interest.

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Table 1: Physico-chemical indicators

Indicators	Goat meat "Zaanen"	Goat meat "Alpine"	Goat meat "Nubian"	mutton
Mass fraction of moisture, %	79.5±8.0	79.9±8.0	77.7±0.77	74.2
Mass fraction of fat, %	2.1±0.3	2.1±0.3	2.4±0.4	7.6
Mass fraction of protein, %	17.5±2.6	17.0±2.6	19.3±2.9	16.3
Mass fraction of ash, %	0.80±0.12	0.92±0.14	1.21±0.17	1.2

Table 2: Vitamin and mineral composition of goat meat

Vitamins	Goat meat "Zaanen"	Goat meat "Alpine"	Goat meat "Nubian"
B3, mg\100g	5.20±1.04	6.76±1.35	5.62±1.12
B5, mg\100g	0.62±0.12	0.53±0.11	0.59±0.12
B6, mg\100g	0.64±0.16	0.64±0.16	0.52±0.13
D3, mcg\100g	>0.1	>0.1	>0.1
E, mg\100g	0.32±0.06	0.27±0.05	0.33±0.07
Mineral composition			
Potassium, mg/kg	2470.10±370.52	1693.22±253.98	4125.83±618.87
Sodium, mg/kg	852.27±136.36	1005.83±160.93	1518.21±242.91
Magnesium, mg/kg	148.71±22.31	125.33±18.80	295.88±44.38
Zinc, mg/kg	37.95±7.43	25.14±5.13	15.78±3.44
Iron, mg/kg	27.28±6.18	87.55±12.83	11.42±4.00
Manganese, mg/kg	0.52±0.10	0.27±0.05	0.21±0.04
Calcium, mg/kg	148.32±25.21	160.79±27.33	79.27±19.82

Figure 1: Amino acid composition

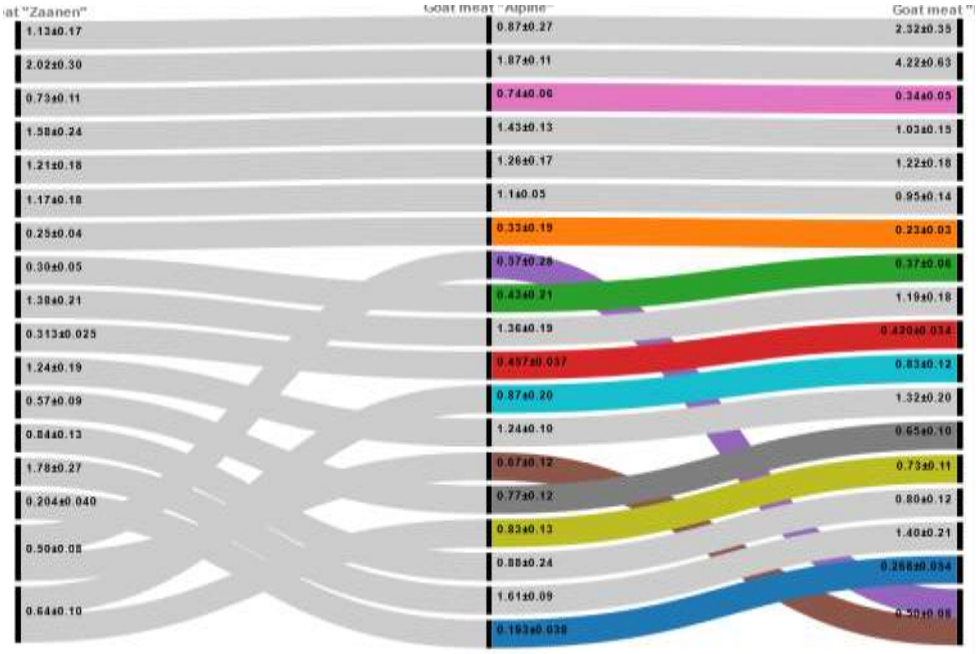

Figure 2: Amino Acid score

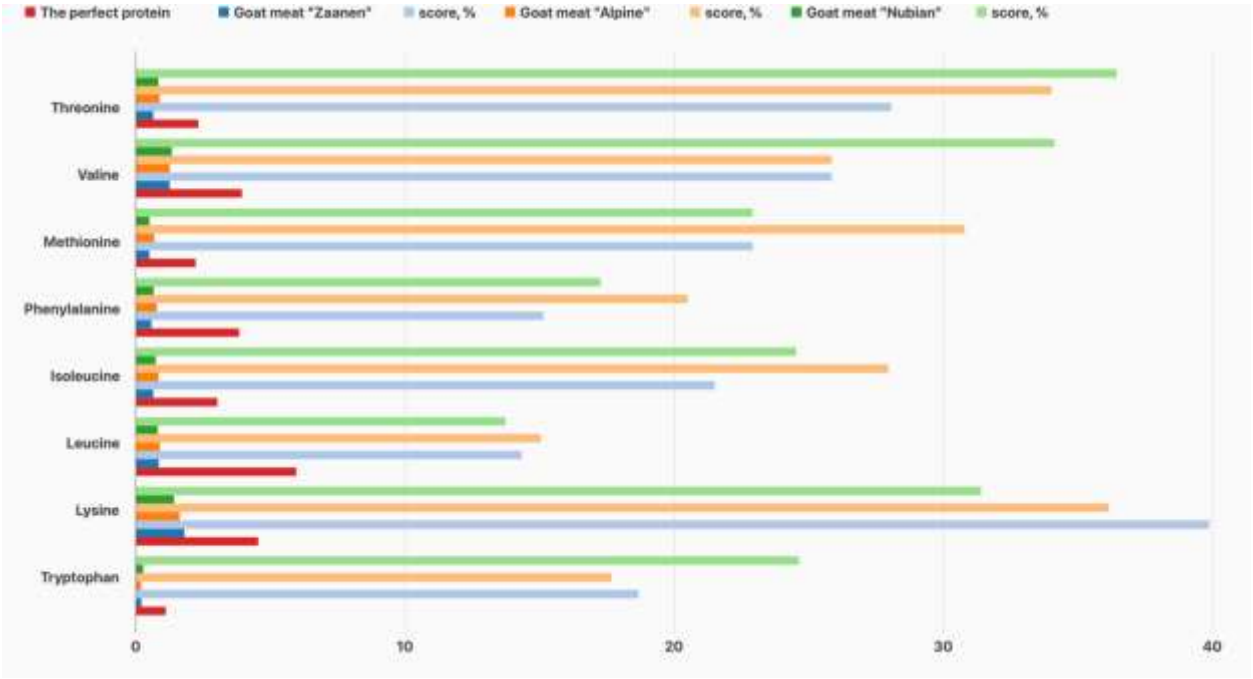

Figure 3: The composition of fatty acids of various breeds of goat meat, % of the total

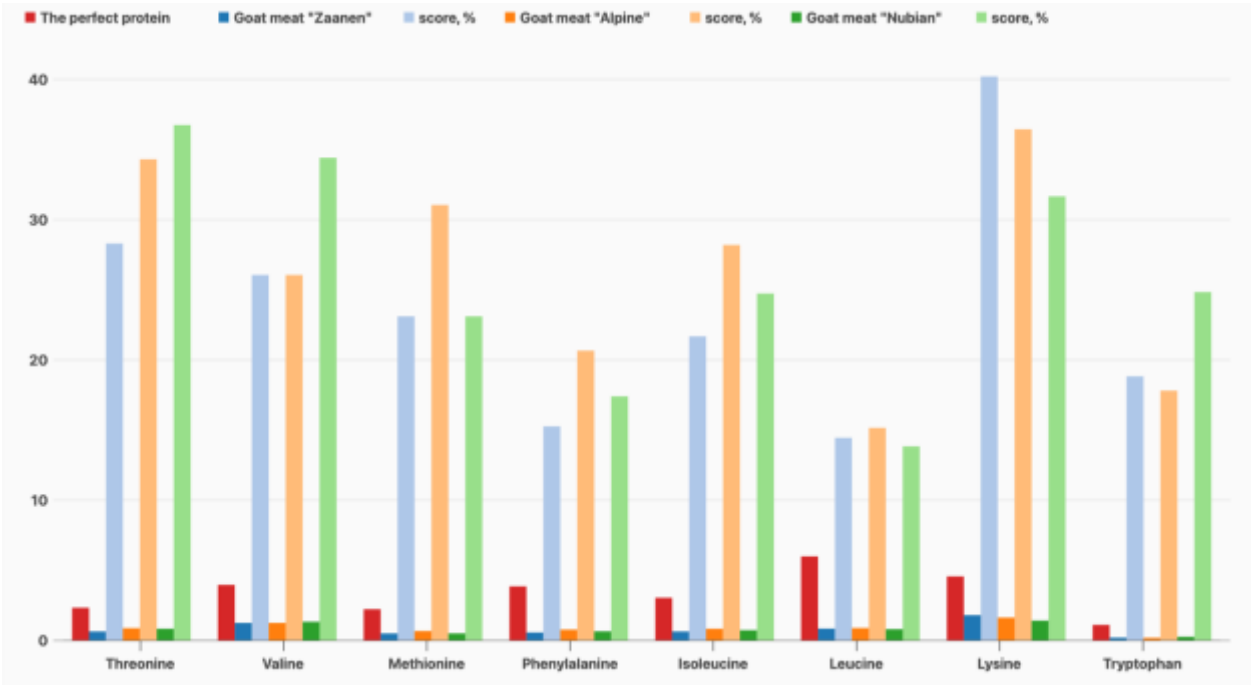

Figure 4: Moisture binding capacity of goat meat of different breeds