RESEARCH ARTICLE

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Chemical composition of meat from different species of animals

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Abstract
The study aimed to comparatively examine meats in terms of chemical composition originating from beef, lamb, chicken, and rabbit consumed in Türkiye and to reveal their superior aspects compared to each other and also to determine the place of rabbit meat, which is not commonly consumed among other meats. As material of the study 48 meat samples were used, 12 from each of the beef, lamb, chicken, and rabbit species provided that each of them belonged to a different animal. Moisture, ash, crude protein, and crude fat levels of the meat samples were compared between meat sources. The highest value in terms of fat and ash ratio were determined in lamb meat ($P<0.001$). Chicken meat had the highest protein ratio. Rabbit and lamb meats were followed, respectively ($P<0.001$). In terms of moisture beef meat had the highest values and there was no significant differences between other source of meat. In conclusion, as rabbit meat had higher protein ratio and lower fat ratio compared with other meat sources, it would be beneficial to expand the production and consumption. Chicken meat was advised to include in diets of patients suffering from obesity or cardio-vasculer diseases because of the highest protein and lower fat content. Lamb meat should be an indispensable part of diets due to its rich ash content. As the highest moisture content beef it could be preferred for making different kinds of meat by-products and consumed by the majority of people.
Keywords: Ash, Crude fat, Crude protein, Meat, Moisture

INTRODUCTION

Population growth and the rapid decrease in natural resources reveal the importance of healthy and adequate nutrition. For this reason, plant and animal production is very important. The fact that animal products are more valuable in nutrition and increases the importance of the livestock sector. Consumers' access to these products at lower costs and the amount of animal protein consumption in diets are important parameters that give information about the development level of countries (Frunză et al., 2023).

According to the OECD-FAO data of 2021, while meat consumption per capita was 35.2 kg in the world, this rate was 69.5 kg in developed countries and 27.6 kg in developing countries. In terms of animal species, per capita consumption of cattle, lamb, pork, and poultry in 2021 was reported as 6.3 kg, 1.8 kg, 11.8 kg, and 15.1 kg respectively in the world. It was reported that 11.1 kg of beef, 4.2 kg of lamb, and 21.9 kg of chicken meat were consumed in Türkiye.

In recent years, the quality of the yields obtained from animals has gained importance as well as the quantity. In parallel with the increase in their education

level and socio-economic status, consumers also consider nutrient content and quality characteristics in product selection. Meat quality has become a more demanded issue due to the awareness of consumers about eating quality and nutritional value. The sensory qualities of meat also have great importance in terms of consumer preference. At the purchasing stage, consumers generally evaluate the color and oiliness of raw meat as quality criteria. The flavor of the meat consumed is related to softness, juiciness, aroma, and taste. A quality meat should be soft, high in moisture, containing more muscle fibers than connective tissue, pink in color, and have a suitable aroma (Kumar et al., 2023; Nutautaitė et al., 2023).

Moisture, crude protein, crude fat, and ash ratio constitute the chemical composition of meat. It is varied according to the species of animal, genotype, sex, age, body condition score, nutritional status, and muscle structure of the animal (Ketoon et al., 2014). Since chicken meat is rich in protein with low fat content, it is an indispensable food source for patients with cardiovascular system and also for people undergoing obesity treatment. In addition, in economic terms, its consumption is in the first ranks in Türkiye, since its price is more reasonable compared to beef and lamb meat. Rabbit meat is an important functional food with high nutritive value due to its lower fat content, higher unsaturated fatty acids, and containing essential amino acids and some vitamin groups. In studies based on red meat consumption levels, the most consumed red meat is beef and lamb, sheep, goat, and kid meat follow it (Akçay and Vatansever, 2010; Kaygısız et al., 2022).

In terms of today's economic conditions, meat of beef and lamb are among the foods that people from all walks cannot easily consume. Chicken meat is preferred more than beef and lamb meat because the price of the chicken meat is relatively cheaper. While rabbit meat production is made professionally as an alternative meat source in China, Egypt, and many European countries; it is a meat product that is not widely consumed in Türkiye (Poławska et al., 2013; Saygin and Demirbaş, 2017; Saygın and Demirbaş, 2018).

The study aimed to comparatively examine meats originated from beef, lamb, chicken, and rabbit consumed in Türkiye in terms of nutrient content, and to reveal their superior aspects compared to each other, and to determine the place of rabbit meat, which is not commonly consumed among other meats.

MATERIALS AND METHODS

This study was carried out with the permission of Balıkesir University Animal Experiments Local Ethics Committee dated 18/05/2023 and numbered 2023/4-3.

Material

In the study, a total of 48 meat samples, 12 from each of the beef, lamb, chicken, and rabbit species, were used, provided that each of them belonged to a different animal. Beef samples were obtained from 2-3 years old Holstein steers, lamb samples were from 3-6 months Kıvırcık × Merino crossbred lambs, chicken samples were obtained from Ross 308 broiler hybrids slaughtered at 42 days of age, and rabbit meat samples were from New Zealand rabbits slaughtered at 3 months of age. Within the scope of the study, the chemical composition of the meat was investigated using the methods reported in AOAC (2000).

Method

For determination of moisture, the meat samples were dried at 110°C for 24 hours as the drying method (AOAC, 950.46) Weights were recorded and moisture content was calculated. The Kjeldahl method (AOAC, 928.08) was used for crude protein determination. Analysis was carried out by following digestion, distillation and titration steps. Ash content was determined by weighing the sample after it was incinerated at 550°C for 4 hours (AOAC, 920.153). Crude fat content was determined by the Soxhlet extraction (AOAC, 991.36) method as extracting the samples with ether by melting the fat in it.

Statistical Analysis

The research findings were analyzed with the SPSS 25.0 package program. Significant differences between the groups were determined by one way analysis of variance. Tukey test was used for multiple comparisons between groups with significant differences. The significance level was determined as 0.05.

RESULTS AND DISCUSSION

The chemical composition ratios of meat samples obtained from different species of animals in the study were given in Table 1.

Beef had the highest moisture content ($P<0.001$) shown in Table 1. Lamb, rabbit, and chicken meat had lower values and no significant difference was found between them (Figure 1).

Water has the highest proportional value in the composition of meat (65-80%). It is an important thermoregulator and solvent as well as taking important roles in cell and organ metabolism also transport of metabolites and wastes (Ketoon et al., 2014). The water holding capacity of the meat is an important factor affecting the appearance, color, tenderness, taste, and aroma of the meat (Apple and Yancey, 2013). The amount of water in the meat is an important factor affecting the profitability in terms of weight loss during the waiting processes of the meat (resting, packaging, freezing, transportation). At the same time, meat that does not lose its water depending on the cooking methods and is able to keep its content is evaluated quality meat category (Belichovska et al., 2017; Lima et al., 2022).

Table 1. Chemical composition values of meat samples obtained from different species of animals

Meat Sample	Moisture (%)	Ash (%)	Crude Fat (%)	Crude Protein (%)
Beef (n = 12)	75.52 ± 0.64 a	1.28 ± 0.09 a	0.81 ± 0.10 a	20.67 ± 0.50 a
Lamb (n = 12)	71.15 ± 0.75 b	2.25 ± 0.05 b	2.99 ± 0.57 b	22.16 ± 0.28 ab
Rabbit (n = 12)	72.34 ± 0.93 b	1.36 ± 0.03 ac	0.68 ± 0.06 a	23.65 ± 0.45 b
Chicken (n = 12)	71.79 ± 0.35 b	1.60 ± 0.06 c	0.69 ± 0.11 a	27.60 ± 0.49 c
P	***	***	***	***

a, b, c: Values within a column with different superscript differ significantly at P<0.05, ***: P<0.001

In the study moisture values determined from beef were similar to the values found in other studies (Ngom et al., 2022; Salim et al., 2023; Santana et al., 2023). However, the moisture value in Korean Hanwoo cattle was reported to be lower (69.21%) than the determined value (Bostami et al., 2023). The reason for this could be interpreted as the proportionally higher fat content in the meat composition of Korean Hanwoo cattle. The moisture content in lamb meat was similar (Junkuszew et al., 2020; Khal-Azzawi and Albashr, 2022; Lima et al., 2022), lower (Mioč et al., 2007; Meng et al., 2023; Radzik-Rant et al., 2023) or higher than (Romero-Bernal et al., 2017; Liang et al., 2023) other reported researches. The moisture content reported for chicken meat was similar (Silva Frasao et al., 2021; Xu et al., 2021) to the rates found in the study. Since most of the chicken meat offered for commercial consumption in the market is hybrid, it is expected that the data obtained would be uniform. The moisture content found for rabbit meat in the study was similar to the moisture rates reported in other studies (Bhatt et al., 2023; Kumar et al., 2023).

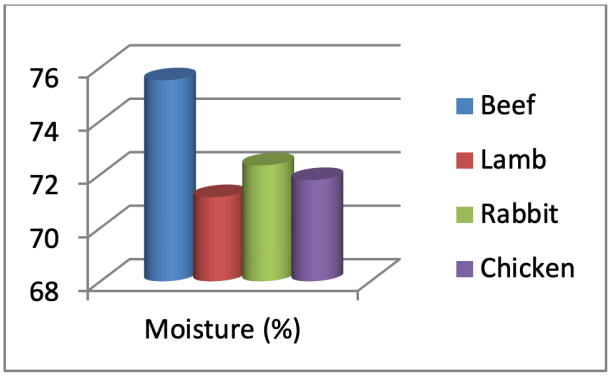

Figure 1. Moisture content of meat samples obtained from different species of animals

While the highest value in terms of ash ratio was determined for lamb (Figure 2); beef ash ratio was found to be lower than chicken meat (P<0.001). There was no significant difference between beef and rabbit meat also chicken and rabbit meat in terms of ash content as shown in Table 1.

Ash is the mineral substance of the meat and very important for human health. It is generally stored in teeth and bones (calcium, phosphate, magnesium). Apart from this, there are also mineral substances stored in body fluids (iron, sodium, potassium), enzymes (zinc), and nucleotides (phosphorus) (Ketoon et al., 2014). Because of mineral deficiencies caused significant discomfort in the body, it is very important to take them with food sources (Williams, 2007; Soriano-Santos, 2010; Pereira and Vicente, 2013; Romero-Bernal et al., 2017).

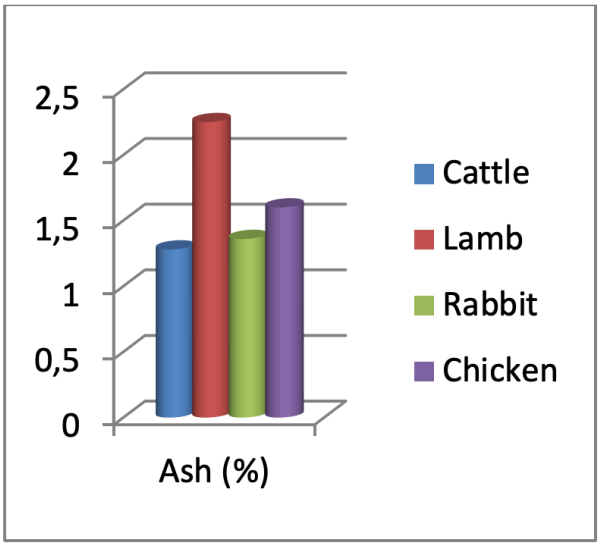

Figure 2. Ash content of meat samples obtained from different species of animals

The ash ratio in the lamb meat composition is higher than the values reported in the previous studies (Lima et al., 2022; Mercan et al., 2022; Liang et al., 2023). For the beef meat composition values although Santana et al. (2023) founded higher ash values; some of researchers found similar values (Oliveira et al., 2021; Bostami et al., 2023). Rabbit ash ratios found in the study were similar (Cardinali et al., 2015; Galeano-Díaz et al., 2023) higher (Neagu et al., 2023; Nutautaitė et al., 2023) than the other studies. Chicken ash values were found lower (Hashim et al., 2013; Cullere and Dalle Zotte, 2018) or higher (Sugiharto et al., 2022; Fathi et al., 2023) than previous reports.

While chicken meat had the highest value in terms of crude protein; it was determined that rabbit, lamb, and beef meat contain protein at decreasing rates, respectively (P<0.001) (Figure 3). There were no significant differences between lamb and rabbit meat in

terms of crude protein ratio. Beef and lamb meat had the lowest protein ratio as shown in Table 1.

Since proteins are the basic building blocks of the organism, they are key elements that should be included in diets. Proteins are essential nutrients that enable the development of muscles and organs in youngs and direct the body functions in adults. An adult person needs about 70-80 g of protein per day. About half of this value should be from animal origin. Protein content in meat is under the influence of many factors such as species, genotype, age, gender, and ration composition. Animals with the same genotype may have different nutrient contents. (Pereira and Vicente, 2013; Marangoni et al., 2015). In human nutrition, proteins from animal origin have an important place in terms of essential amino acids and fatty acids include. It is generally desirable to have a higher protein content in meat products (Akçapınar and Özbeyaz, 2021).

The protein values found for cattle in the study were similar to some of the values found in the researches (Hamed Hammad Mohammed et al., 2020; Pouzo et al., 2023; Santana et al., 2023), higher than some (Salim et al., 2023) and lower than some (Oliveira et al., 2021; Ngom et al., 2022). While the values reported for sheep were in agreement with (Costa et al., 2009; Romero-Bernal et al., 2017; Radzik-rant et al., 2023) or higher than literature reports and findings (Mioč et al., 2007; Lima et al., 2022; Latoch et al., 2023; Lunesu et al., 2023; Uushona et al., 2023). The rates found for chicken meat were higher than the reported values (Cullere and Dalle Zotte, 2018; Xu et al., 2021; Sugiharto et al., 2022; Weng et al., 2022; Fathi et al., 2023). The protein values found for rabbit meat were similar to the results found in the other studies (Belichovska et al., 2017; Cullere and Dalle Zotte, 2018; Frunză et al., 2023; Galeano-Díaz et al., 2023).

While the highest value in terms of fat ratio was determined in lamb meat ($P<0.001$) (Figure 4); there was no significant difference between chicken, beef, and rabbit meats (Table 1).

Fats are related tenderness, flavor, and aroma of meat products. In terms of human health, unsaturated fatty acids desired to be higher in the composition of fatty acid profile of meat and saturated fatty acids should be lower. It is important for meat products to include lower fat content in the diets of individuals who have problems with the cardio-vascular system or obesity. The fat ratio in the meat composition varies depending on various factors (Williams, 2007; Pereira and Vicente, 2013; Marangoni et al., 2015). Since the muscle development is higher in male animals, the protein ratio is proportionally higher, fat content is lower (Ngom et al., 2022; Santana et al., 2023). Carcass score is also one of the parameters to be taken into account as it affects fatness (Rubayet Bostami et al., 2018).

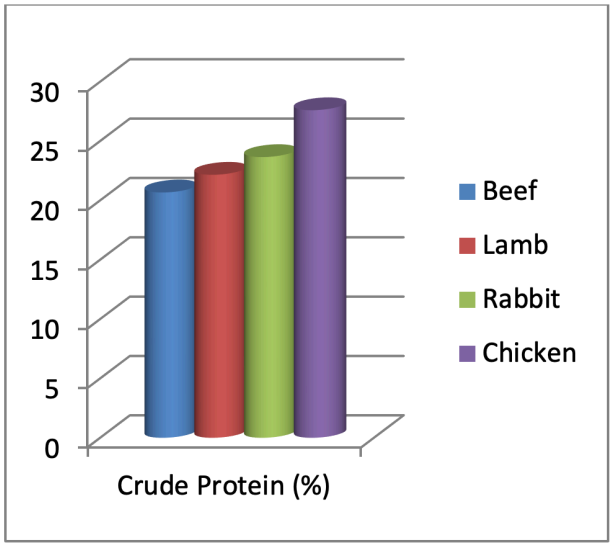

Figure 3. Crude protein content of meat samples obtained from different species of animals

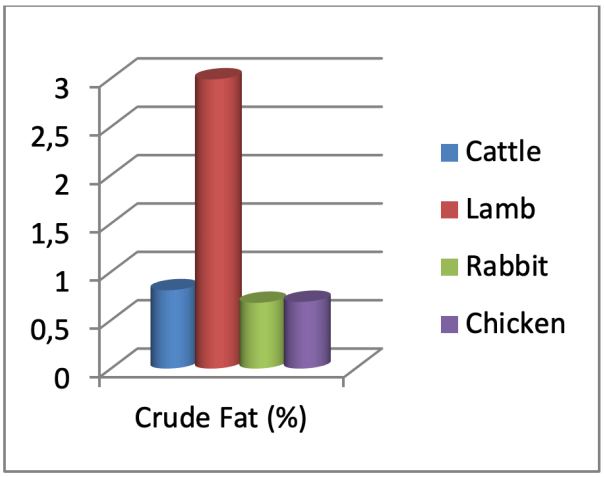

Figure 4. Crude fat content of meat samples obtained from different species of animals

The fat values presented in the literature reports were similar (Romero-Bernal et al., 2017), lower (Mioč et al., 2007), or higher (Junkuszew et al., 2020; Lima et al., 2022; Latoch et al., 2023) for lambs; higher for beef (Rubayet Bostami et al., 2018; Hamed Hammad Mohammed et al., 2020; Ngom et al., 2022; Santana et al., 2023); higher (Cullere et al., 2018; Xu et al., 2021) and similar (Weng et al., 2022; Fathi et al., 2023) for chicken; similar (Cardinali et al., 2015; Dalle Zotte et al., 2018; Kumar et al., 2023) and higher (Haque et al., 2016; Frunză et al., 2023; Neagu et al., 2023; Nutautaitė et al., 2023) for rabbit meat.

CONCLUSION

As a result of the study, it was determined that different species of meat animals have varied rates of moisture, ash, crude fat, and crude protein levels. Chicken meat had the highest protein ratio. Rabbit and lamb meats were followed it. Beef meat had the highest values of

moisture value. The highest value in terms of fat and ash ratio were determined in lamb meat. Chicken meat was advised to include in diets of patients suffer from obesity or cardio-vasculer diseases because of higher protein and lower fat content. Lamb meat should be an indispensable part of diets due to its rich mineral content. As the highest moisture content beef meat could be preferred for making different kinds of meat by-products and consumed by the majority of people. As rabbit meat had higher protein and lower fat ratio compared with other meat sources, it would be beneficial to expand the production and consumption of rabbit meat.

COMPLIANCE WITH ETHICAL STANDARDS

Peer-review

Externally peer-reviewed.

Conflict of interest

The authors declare that they have no competing, actual, potential or perceived conflict of interest.

Author contribution

Experimental design was planned by BY, MZ, MG, ÖVA; meat samples were collected by BY, chemical composition analysis were performed by MZ, MG, BBP, ÇE, EO; statistical analysis were done by BY and ÖVA; results were evaluated by BY, MZ and ÖVA; manuscript was written by BY and all authors contributed to the final version of the manuscript.

Ethics committee approval

This study was carried out with the permission of Balıkesir University Animal Experiments Local Ethics Committee dated 18/05/2023 and numbered 2023/4-3.

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Data availability

Data could be shared if requested from corresponding author (B. Yaranoğlu).

Consent for publication

Not applicable

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