Evaluation of the quality of beef composition according to breed

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Abstract. Meat from cattle occupies the first places in terms of products intended for human consumption that contain a rich amount of iron after cereals and other seeds. Meat in general occupies an essential role in human nutrition both due to the continued increase in nutrients and due to the property of increased digestibility. Currently, due to the evolution of technological processes and methods of preservation of beef and not only, the meat industry has progressed towards continuous development, due to the acuities regarding the pretability of the products. Beef can be differentiated from a compositional point of view due to the exploitation system, nutrition, age but also due to the breed (specialized breeds for meat, milk or mixed).
Key Words: beef, food, physical-chemical composition, protein/collagen ratio, quality.

Introduction. According to Halagarda & Wojciak (2022), meat and meat-based preparations are labeled as an essential group of traditional foods in many countries, so that humanity has begun to show a major interest for the quality of beef. Essential indicators used in evaluating the degree of food quality are obtained from examinations regarding the nutritional, physico-chemical composition, microbiological testing and a primary aspect being the degree of acceptability of the final consumer (Pop et al 2011). This broad field regarding food quality represents a fundamental basis for forming a healthy society at global level (Savu & Mihai 1997; Druga 2004).

Regarding the compositional quality characteristics, they can be influenced by the species of the animal, the age, the sex, the way of feeding, the welfare conditions of the animal and the method of slaughter (Tudor et al 2009; Mihaiu 2010). Meat is an essential source of energy and nutrients for humanity. According to studies in the specialized literature, meat is an important food in the human diet due to its physico-chemical composition rich in nutrients with a high biological value (proteins, minerals and vitamins) (Mihaiu 2010; Pop et al 2011). The correlation between carcass consistency characteristics and meat quality is not fully elucidated and may be determined by certain factors: breed, age, growth rate, body weight, feed and living conditions of the animal (Bonny et al 2016).

In another study, Vestergaard et al (2000) stated that the influence of breed on muscular, sensory and nutritional qualitative characteristics is a difficult process to establish and explain. Studies conducted over time in different countries of the world (USA, Australia, Great Britain, Japan, France, Poland) certify that most consumers have the same requirements regarding beef. Consumers want meat at an affordable price, with superior organoleptic quality, hygiene and nutrition at the highest standards, which will be obtained through good animal husbandry practices and respect for the environment (Hocquette 2003; Albechaalany et al 2024). As for the physico-chemical composition of

the meat, it is given by the ratio between the tissues that form it, so it can be influenced by certain factors: species, breed, age, sex and welfare conditions. Young animals have a higher amount of water compared to adults or old ones (Dinnella et al 2023). The state of fattening is the most important factor regarding the influence of the physico-chemical composition (Biesalski 2005).

According to Halagrada & Wojciak (2022), the protein digestibility of beef from cattle is very high in the distal portion of the small intestine, so if the beef is subjected to the thermal process for about 30 minutes, it can influence the digestibility process, by decreasing it in the body. Beef is a superior source of protein due to its high nutritional value (Ikonić et al 2010). Protein deposition in muscle is influenced by several factors, in particular the nutrition provided to the animal, the growth systems and the welfare of the animal, so that the higher the proportion of fat, the lower the proportion of protein content (Vidal et al 2022). The amount of intramuscular fat plays an important role in determining nutritional and sensory properties. Studies demonstrate the importance of polyunsaturated fatty acids (Omega 6 and Omega 3) for the proper functioning of the human body (Mikami et al 2022). The amount of intramuscular fat is determined by the number and size of adipocytes located intramuscularly. The influence of sex on the lipid content is due to the hormonal point of view. Therefore, in castrated males, a decrease in the amount of testosterone is automatically associated with an increased fat deposition (Bureš & Bartoň 2018).

Fatty acids in beef can be influenced by genotype, such that a reduced amount of intramuscular fat is correlated with a higher amount of polyunsaturated fatty acids (Miller et al 1987). Beef is a beneficial source of conjugated linoleic acid, which is produced in the rumen, with benefits for the consumer (Sinclair et al 2001). The totality of activities programmed and implemented in view of the qualitative nature of a food, demonstrates the assurance of a quality of a food. In order to obtain a higher quality food, activities must be thought, built and elaborated, and not just checked Albechaalany et al (2024).

The purpose of this experiment was to observe the compositional differences, depending on the type of breed, knowing that there are breeds specialized for meat, milk or mixed breeds. The main objective pursued in the current study was to obtain percentage values regarding the physical-chemical composition of beef from the three breeds studied.

Material and Method. The material used in this study was represented by 15 beef samples from two slaughterhouses in Satu Mare County and Alba County, Romania. The age of the animals was close (up to 1 year). Samples were collected randomly, 5 samples for each breed, immediately after the slaughter process, both at the beginning and at the end of the transfer program. The meat samples from Bălțată Românească were collected from Alba Iulia county, and those from Belgian Blue and Black Angus were collected from a slaughterhouse from Satu Mare county. The study was carried out between March and April 2024, and the samples were processed in the food safety laboratory of the Faculty of Veterinary Medicine Cluj-Napoca. The compositional parameters were monitored in the experiment: water, proteins and fats.

The samples were kept under refrigeration conditions (4ºC) for several hours, being delivered to the analysis laboratory. Samples were collected from the pulp region of each carcass, following the methodological norms recommended by the National Sanitary and Food Safety Agency, thus we randomly took samples from the carcasses of three breeds of cattle: Bălțată Românească, Black Angus and Belgian. We performed an average of the results of the parameters obtained for each breed separately and the interpretation of the data was performed using the Student's t-test.

The determination of the raw chemical composition of the beef was carried out with the help of the FoodScan Lab analyzer. The FoodScan Lab analyzer is an analyzer used for production control and for the control of a wide range of products in the food industry. The technology of infrared transmission (NIT - Near Infrared Transmittance) is the basis of this analyzer that realizes the simultaneous and correct determination of several parameters. Thanks to a halogen lamp, which is located behind the analyzer, the light is positioned through the optical fiber in the monochromator inside the instrument.

The monochromator is provided with monochromatic light in the spectrum between 850 and 1050 nm. The light will enter through the optical fiber and is positioned towards the collimator lens system, which is located above the sample cup. The light is transmitted through the sample to be analyzed and the unabsorbed light reaches the detector. The detector measures the amount of light and will transmit the value to the signal processor that communicates with the PC and will calculate the final result. The preparation of the sample involves chopping it either with an electric chopping machine or with the help of an Ultraturax type device. The sample to be analyzed must be very well homogenized. After fulfilling the requirements regarding the sample, it will be inserted into the tray of the device for analysis. The rotation of the cup around the explored sample allows the analysis of different parts of the sample, called subsamples. The subsamples are located on a concentric circle in the cup with the sample, giving the possibility to obtain a representative result, even in the case of an inhomogeneous sample.

The results obtained are represented by the content of water (%), fat (%), collagen (%) and protein (%).

Also in the case of this study, we measured the collagen/protein ratio using the following formula:

$$\text{Collagen/protein ratio} = \frac{\text{Collagen}}{\text{Protein}} \times 100$$

Results and Discussion. Meat is a rich source of high-quality protein, with an amino acid composition that compensates for deficiencies in other foods (Buda et al 2014). From a physico-chemical point of view, meat generally contains water, nitrogenous and non-nitrogenous extractive substances, carbohydrates, lipids, mineral salts, vitamins, enzymes and hormones (Mihaiu 2010).

Using the FoodScan Lab analyzer, we obtained the percentage values of beef from the three breeds studied, the compositional elements analyzed in the case of the study being: water, protein, fat and collagen (Pop et al 2013). According to specialized literature, the composition of beef is composed of 75% water and 25% dry matter, but these values may vary depending on age, sex, breed, animal nutrition, physical activity performed and the type of muscle (Raes et al 2003; Biesalski 2005; Lamanov et al 2020). When cattle reach mature body size, fat accumulation can continue but protein accumulation decreases (Owens et al 1995).

The water content varied as follows: 75.93% for Bălțată Românească, 76.09% for Black Angus and 76.29% for Belgian Blue. The lowest values for protein were obtained for Belgian Blue, 22.43%, followed by 22.64% for Black Angus and 24.62 for Bălțată Românească (Table 1). The fat content varied between 1.44% for Bălțată Românească and 3.32% for Belgian Blue (Table 1). All values obtained are within the reference values for beef (Raes et al 2003).

Table 1

Results of the physico-chemical parameters from the beef samples

Sample breed	Parameter	$X \pm S_x$	V (%)
Bălțată Românească	Water (%)	75.93±0.32	0.93
	Protein (%)	24.62±0.32	2.86
	Fat (%)	1.44±0.12	18.92
Belgian Blue	Water (%)	76.29±0.17	0.49
	Protein (%)	22.43±0.04	0.43
	Fat (%)	3.32±0.15	10.34
Black Angus	Water (%)	76.09±0.29	0.87
	Protein (%)	22.64±0.14	1.36
	Fat (%)	1.88±0.16	19.41

Note: V = variability; X = average value; Sx - standard deviation.

Breed can significantly influence the antioxidant potential of beef, for example in the case of an experiment in Poland carried out on several breeds of cattle, it has been found that breeds of cattle producing meat show high levels of antioxidant status, compared to breeds producing of milk (Kostusiak et al 2023). The study by Solarczyk et al (2020) concluded that the crossbreeding of cattle breeds can significantly influence the composition and nutritional quality of the meat. Hozáková et al (2020) also reported that the genetic base and other external factors can influence the composition and quality of beef. In order to obtain qualitative compositional results regarding beef, specific production systems must be chosen, with the help of selection programs (Yokoo et al 2010).

Along with the evaluation of the physico-chemical composition of beef for the three breeds considered in this experiment, we also calculated the collagen/protein ratio, which is also an important parameter for the evaluation of meat quality. The results are presented in Figures 1 and 2.
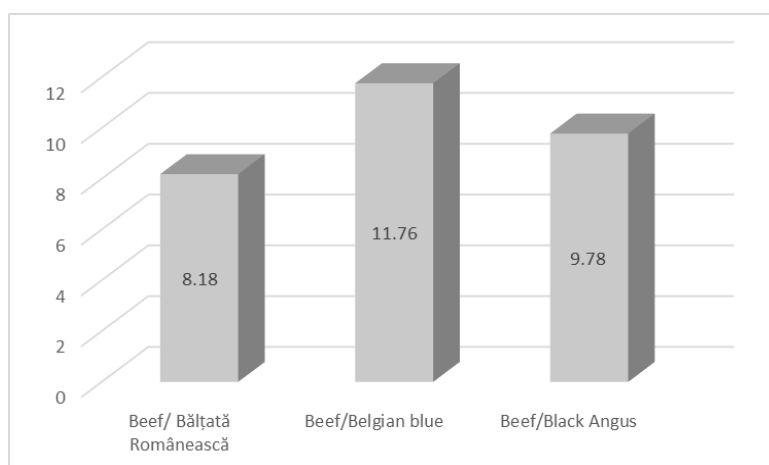

Figure 1. The minimum values for the collagen/protein ratio (%) from beef (Bălțată Românească, Belgian blue, Black Angus).
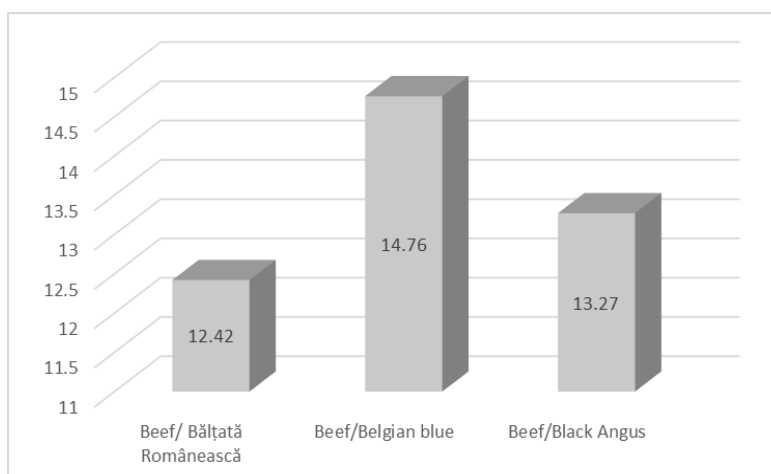

Figure 2. The maximum values for collagen/protein ratio (%) from beef (Bălțată Românească, Belgian blue, Black Angus).

The collagen/protein ratio for the Bălțată Românească breed was in the range of 8.18-12.42%; 11.76-14.76% for Belgian Blue and 9.78-13.27% for Black Angus. All samples fell within the reference values specified in the specialized literature (Kostusiak et al 2023).

Protein-concentrated feed given in the early fattening phase of cattle does not affect the sensory characteristics of Japanese black beef, but changes the values of the physicochemical composition of the meat, even the free amino acids (Okumura et al

2008). A study conducted to evaluate the physico-chemical composition of the meat and the quality of the final carcass in cattle, concluded that feeding corn silage for 7 months compared to feeding concentrate does not significantly influence the protein content values, fats and collagen; also within the experiment it is stated that there were no significant changes regarding the proportion of the front and back quarters of the carcasses or the meat/bone ratio (Sami et al 2012).

In the case of an experiment in which bulls were castrated, the assessment of the physico-chemical composition and the sensory examination for the longissimus muscle was followed, so the authors came to the conclusion that there are differences in certain aspects related to flavor, juiciness, and the amount of protein. Therefore, the results of the study suggest that late castration is a management tool for beef production as it enables an aggregate commercial value (Morón-Fuenmayor et al 2010). The evaluated beef from Mexico and the USA from retail stores showed similar results regarding quality characteristics and sensory traits. The value of the content of fat and polyunsaturated fatty acids was higher in beef samples from USA (Gonzalez-Rios et al 2010).

The authors of a study carried out on beef meatballs considered the addition of carrot pomace as a solution to reduce food waste, so they added percentages of 1%, 3% and 4.2% of carrot pomace in the beef meatballs. The results of the experiment indicated a decrease in humidity for the higher percentages of carrot pomace, including the color being modified. Also in the case of this study, a higher cooking yield was found and the textural and sensory properties showed noticeable changes (Richards et al 2024).

Conclusions. This study attests that the physico-chemical composition parameters of the meat from the two slaughterhouses have individual average values very close to the reference averages specific to each individual component, so it can be stated that the meat samples collected from all three breeds of cattle correspond under compositional aspect with the specialized literature and falls within the standards in force.

Conflict of interest. The authors declare that there is no conflict of interest.

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