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Fatty acids, their proportions, ratios, and relations in the selected muscles of the thigh and roast beef

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ABSTRACT

The study aimed to examine, compare, and statistically evaluate the quality of the beef thigh and roast beef muscle in terms of the fatty acids profile concerning human health. *Musculus semimembranosus* and *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the roast beef were used for analysis to evaluate the fatty acid profile. Chemical analysis of the thigh and roast beef muscle samples was performed using Fourier transform infrared (FTIR) spectroscopy. The measured data were statistically processed according to descriptive characteristics, analysis of variance, and differences were tested using Scheffe´s test at $\alpha = 0.05$. The SAS program package, version 8.2, was used to evaluate the results statistically. A statistically significant difference ($p \leq 0.05$) was recorded in the dry matter proportion between m. quadriceps femoris and m. longissimus dorsi. A statistically significant difference was found in the intramuscular fat proportion, polyunsaturated fatty acid proportion, the ratio of polyunsaturated fatty acids to saturated fatty acids, the ratio of polyunsaturated fatty acids to monounsaturated fatty acids, as well as between *m. semimembranosus* and *m. longissimus dorsi* and between *m. quadriceps femoris* and *m. longissimus dorsi*. Strong, statistically significant ($p \leq 0.01$, $p \leq 0.001$) correlations were found mainly between intramuscular fat and polyunsaturated fatty acids, between intramuscular fat and the ratio of the polyunsaturated fatty acids to saturated fatty acids, between intramuscular fat and the ratio of polyunsaturated fatty acids to monounsaturated fatty acids. In conclusion, it was stated that the muscles of the thigh and roast beef of the young cattle are characterized by statistically significant differences in the proportion of fatty acids. The ratio of polyunsaturated fatty acids to saturated fatty acids meets the recommended values concerning maintaining the health of the food consumer. Still, the ratio of the n-6 to n-3 polyunsaturated fatty acids poses a risk concerning cardiovascular diseases.

Keywords: beef muscle, fatty acid, proportion, ratio, correlation

INTRODUCTION

In general, meat consumption varies by region due to specific eating habits, levels of financial income, and product availability **[1]**. In recent years, beef consumption has decreased and the reasons that explain consumer changes are due to the presence of various factors, such as the replacement of red meat with white meat, which occurs either for nutritional, health or economic reasons, environmental reasons, respectively. Traditionally, the relative price of beef compared to other types of meat was considered a factor that could explain the lower demand. Other factors are being promoted, such as lifestyle, food safety, and a new understanding of consumer interests in the environment or animal welfare, sustainability, and food processing **[2]**, **[3]**, **[4]**, **[5]**.

The aim of our study was to examine, compare and evaluate the quality of selected muscles of the beef thigh and roast beef in terms of fatty acid profile in relation to human health.

Scientific Hypothesis

1. *Musculus semimembranosus* and *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the roast beef affect the intramuscular fat proportion.
2. *Musculus semimembranosus* and *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the roast beef affect the saturated fatty acid proportion.
3. *Musculus semimembranosus* and *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the roast beef affect the monounsaturated fatty acid proportion.
4. *Musculus semimembranosus* and *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the roast beef affect the polyunsaturated fatty acids proportion.
5. *Musculus semimembranosus* and *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the roast beef affect the ratio of the polyunsaturated fatty acids to saturated fatty acids.

MATERIAL AND METHODOLOGY

Samples

Two muscles, *quadriceps femoris* and *semimembranosus,* of the beef thigh and one muscle *longissimus dorsi*, of the roast beef were used for fatty acid analysis.

Animals, Plants and Biological Materials

Sampling for research was carried out on a cattle farm at the foot of the Levočské vrchy (Levoca mountains) in Slovakia. Young Limousine male cattle of 9 months of age weighing 300 kg were used for the research.

Thigh and roast beef from young cattle were sampled and bred in a herd with another 24 pieces of cattle in the free-range system. The young cattle in the fattening ward received a stable feed ration of corn, alfalfa silage, barley straw, and meadow hay, supplemented with a supplementary core mixture during sampling. Thigh and roast beef were transported from the farm to the Institute of Animal Husbandry (Department of Veterinary Disciplines) of the Faculty of Agrobiology and Food Resources, the Slovak University of Agriculture in Nitra, where the muscles were anatomically separated.

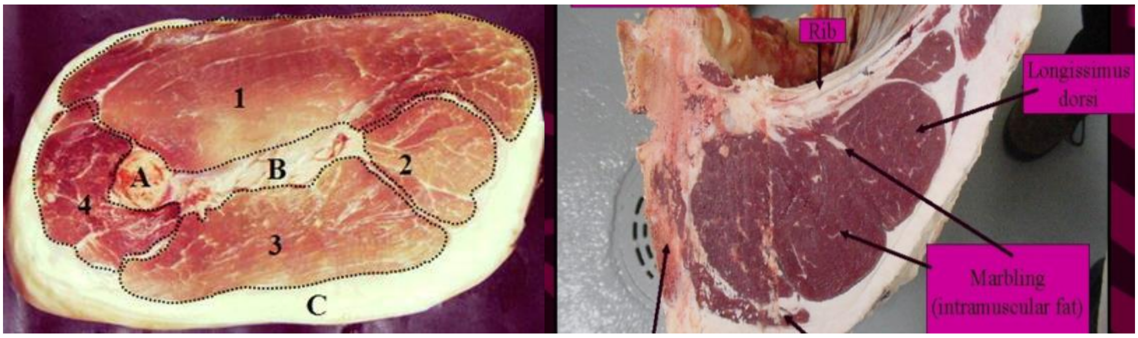

Figure 1 Beef thigh and roast beef muscles used in research. Note: Thigh muscle in cross-section: 1. *musculus semimembranosus*; 2. *m. semitendinosus*; 3. *m. biceps femoris*; 4. *m. rectus femoris* a *m. vastus medialis* (*m. quadriceps femoris*) **[6]**, Roast beef in cross-section: rib; *m. longissimus dorsi*, marbling (intramuscular fat) **[7]**.

Instruments

Scales, type Kern 440-49N with an accuracy of d = 0.01 g, a laboratory mixer, type Grindomix 200 and a laboratory instrument Nicolet 6700 FTIR spectrometer, Thermo Nicolet Corp., Madison, WI were used in the research.

Laboratory Methods

Chemical analysis of beef thigh and roast beef samples was performed according to the Fourier Transform Infrared (FTIR) spectroscopy method in the chemical laboratory of the Institute of Animal Husbandry (Department of Special Zootechnics), Faculty of Agrobiology and Food Resources, Slovak University of Agriculture in Nitra.

Infrared spectroscopy includes the infrared portion of the electromagnetic spectrum. The principle of the infrared spectroscopy method is the use of molecules with specific energy content. This energy content corresponds to the frequencies at which the molecules rotate or vibrate **[8]**. Fourier transform infrared spectroscopy is suitable for qualitative and quantitatively determining ingredient content in foods, including meat, regarding information on the functional group in the infrared spectrum **[9]**. Thigh muscle and roast meat samples were analyzed for dry matter, fat, saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids, n-6 polyunsaturated fatty acids, and n-3 polyunsaturated fatty acids. FTIR spectra were recorded by scanning 4 cm^{-1} at 4000 – 650 cm^{-1}, marked near the middle infrared area. The analytical output was the infrared spectrum illustrated as a function of energy dependence. This energy dependence was expressed as percent transmittance or absorbance units at the wavelength of the incident radiation.

Description of the Experiment

Sample preparation: The individual muscles were divided into 6 equal parts, the so-called partial samples, a total of 18 pieces, which were used to prepare the basic samples. Each sample was prepared according to the official method **[10]**, which is recognized by the Codex-AOAC, particularly for meat and meat products. A laboratory mixer was used, type Grindomix 200. The principle of the method is to mix and homogenize the sample thoroughly. 50 g, which is the analytical sample, was taken and weighed from each basic sample. The analytical sample was quantitatively transferred to a ground glass flask and prepared for chemical analysis.

Number of samples analyzed: 18
Number of repeated analyses: 2
Number of experiment replication: 1

Statistical Analysis

The initial data obtained from the chemical analysis were mathematically calculated for the ratios: polyunsaturated fatty acids to saturated fatty acids, polyunsaturated fatty acids to monounsaturated fatty acids, monounsaturated fatty acids to saturated fatty acids, and n-6 polyunsaturated fatty acids to n-3 polyunsaturated fatty acids. The obtained data were statistically evaluated according to the indicators of descriptive characteristics, i.e. $\bar{x}$ – arithmetic mean and SD – standard deviation, the result of which is information on the accuracy of the measurement. Analysis of variance (ANOVA) was used to compare groups, i.e. the assumption of agreement of variance was verified by the F test (F). A statistical comparison of differences was made between thigh muscles and roast beef using Scheffe´s test. For the results, the p-value of the respective achieved statistical significance was evaluated at the selected level of significance $\alpha = 0.05$. The linear relationship between the two variables was tested according to the Pearson correlation coefficient (r). The values of (r) are set between +1 and -1, and a value of 0 means no linear relation between the data in the file. According to Cohen **[11]**, the value (r) between the two variables means less than 0.1 is trivial dependence, 0.1 to 0.3 is weak dependence, 0.3 to 0.5 is medium dependence, and more than 0.5 is strong dependence. The result of the correlation relationship (r) between the two variables was statistically tested at a significance level of $\alpha = 0.05$, $\alpha = 0.01$, and $\alpha = 0.001$. The SAS program package, version 8.2, was used to evaluate the results statistically. The basic file in each statistical file of thigh muscles and roast beef muscles represented 6 statistical units, 18 ($n \leq 30$).

RESULTS AND DISCUSSION

Dry matter in the selected beef thigh and roast beef muscles

Average proportion and statistical evaluation of the dry matter proportion in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi of the* roast beef is shown in Table 1.

Table 1 Average proportion and statistical evaluation of the dry matter proportion in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *longissimus dorsi* of the roast beef.

			Scheffe´s test, α = 0.05	
Group	**n**	**$\bar{x}$ ±SD, %**	**Beef thigh – *m. quadriceps femoris***	**Roast beef – *m. longissimus dorsi***
Beef thigh – *m. semimembranosus*	6	27.62 ±0.84	*p* >0.05	*p* >0.05
Beef thigh – *m. quadriceps femoris*	6	28.36 ±0.26	*p* ≤0.05	
Roast beef – *m. longissimus dorsi*	6	27.19 ±0.42		
Analysis of variance		F (6.67, *p*≤0.01)		

Note: m. – muscle, n – multiplicity, SD – standard deviation, *p* >0.05 – no statistically significant difference, *p* ≤0.01, *p* ≤0.05 – a statistically significant difference.

Previous studies have also shown that muscle fiber composition is one of the variable muscle growth characteristics that affect meat quality, especially in terms of meat palatability, including affecting taste **[12]**, meat color, pH, water-binding ability, tenderness, and nutritional value of meat **[13]**, components of connective tissue and intramuscular fat **[14]**. Muscle properties can be improved by the efficiency of nutrition and feeding and thus improve the economic value of livestock **[12]**. Wegner et al. **[15]** argue that for beef farms, a proper understanding of muscle characteristics is important to produce meat in maximum quantity and quality. Muscle mass can be maximized through the number and size of muscle fibers and the transformation of muscle fibers.

The dry matter proportion was statistically evaluated according to the analysis of variance, comparing the critical value with the test characteristic, based on which the null hypothesis H_0 was rejected. The result of the comparison shows that the dry matter proportion of the thigh muscles and the roast beef muscle is different in the groups statistically significant F (6.67^{++}, $p \leq 0.01$). The muscles of the thighs and roast beef affected the dry matter proportion.

The dry matter in the *musculus semimembranosus* of the thigh reached an average proportion of 27.62% and in *m. quadriceps femoris* of the thigh slightly higher, 28.36%. The average dry matter proportion was the lowest in *m. longissimus dorsi* of the roast beef from all examined muscles, i.e. 27.19%. The difference in dry matter proportion between *m. semimembranosus* and *m. quadriceps femoris* of the thigh was not statistically significant ($p > 0.05$). Also, the difference in dry matter proportion was not statistically significant ($p > 0.05$) between *m. semimembranosus* of the thigh and *m. longissimus dorsi* of the roast beef. But the difference between *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the roast beef was statistically significant ($p \leq 0.05$). Statistical evaluation of the dry matter proportion results in the thigh muscles and roast beef muscle based on the standard deviation revealed that the largest fluctuation of the measured values was at *m. semimembranosus* of the thigh and the lowest at *m. quadriceps femoris* of the thigh (SD = 0.84 vs. SD = 0.26).

Fresh beef contains 65 to 80% moisture (20 to 35% dry matter) **[16]**. Our dry matter proportion of the beef thigh and roast beef muscles is also within the stated values. Water in beef exists in three forms; free water, immobilized water, and bound water **[17]**.

Intramuscular fat in the selected beef thigh and roast beef muscles

Average proportion and statistical evaluation of the intramuscular fat proportion in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi of the* roast beef is shown in Table 2.

The intramuscular fat proportion was statistically evaluated according to the analysis of variance, comparing the critical value with the test characteristic, on the basis of which the null hypothesis H_0 was rejected. The result of the comparison shows that the intramuscular fat proportion in the thigh and roast beef muscles is different in the groups statistically significant F (22.12^{+++}, $p \leq 0.001$). The muscles of the thighs and roast beef affected the intramuscular fat proportion.

Table 2 Average proportion and statistical evaluation of the intramuscular fat proportion in the *musculus semimembranosus* and in the *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi* of the roast beef.

Group	n	$\bar{x}$ ±SD, %	Scheffe´s test, α = 0.05 Beef thigh – *m. quadriceps femoris*	Scheffe´s test, α = 0.05 Roast beef – *m. longissimus dorsi*
Beef thigh – *m. semimembranosus*	6	0.48 ±0.05	$p > 0.05$	$p \leq 0.05$
Beef thigh – *m. quadriceps femoris*	6	0.48 ±0.11	$p \leq 0.05$	
Roast beef – *m. longissimus dorsi*	6	0.83 ±0.14		
Analysis of variance	F (22.12, $p \leq 0.001$)			

Note: m. – muscle, n – multiplicity, SD – standard deviation, $p > 0.05$ – no statistically significant difference, $p \leq 0.001$, $p \leq 0.05$ – a statistically significant difference.

The intramuscular fat proportion in the *m. semimembranosus* of the thigh reached the average proportion of 0.48% and in *m. quadriceps femoris* of the thigh also 0.48%. The average proportion of intramuscular fat was higher in *m. longissimus dorsi* of the roast beef, of all observed muscles, i.e. 0.83%. The difference in the proportion of intramuscular fat between *m. semimembranosus* and *m. quadriceps femoris* of the thigh was not statistically significant ($p > 0.05$). But the difference in the proportion of intramuscular fat was statistically significant ($p \leq 0.05$) between *m. semimembranosus* of the thigh and *m. longissimus dorsi* of the roast beef. Also the difference in the proportion of intramuscular fat between *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the roast beef was statistically significant ($p \leq 0.05$).

Statistical evaluation of the results of the proportion of intramuscular fat in the thigh and roast beef muscles based on the standard deviation revealed that the measured values fluctuated at *m. thigh semimembranosus* of the thigh SD = 0.05, at *m. quadriceps femoris* of the thigh SD = 0.11, versus *m. longissimus dorsi* of the roast beef SD = 0.14.

The storage of fat in the carcass of bovine animals and the composition of fatty acids in meat play an important role in the variation of dietary properties **[18]**.

Consumers increasingly prefer tasty, juicy, and tender beef. They increasingly seek lower-fat options, believing that such meat is healthier. Intramuscular fat has an important effect on meat palatability due to its specific contribution to influencing juiciness, taste, and tenderness **[19]**. Intramuscular fat storage appears to be regulated by various factors as opposed to those that regulate fat storage in adipose tissue, such as subcutaneous, and metabolic differences between them. Intramuscular adipocytes have higher activity of hexokinase and phosphofructokinase enzymes. Subcutaneous adipose tissue exhibits higher levels of lipogenic enzymes, such as NADP-malate dehydrogenase, phosphogluconate-6-dehydrogenase, and glucose-6-phosphate dehydrogenase, which play important functional roles in lipid metabolism **[20]**.

Saturated fatty acids in the selected beef thigh and roast beef muscles

Average proportion and statistical evaluation of the saturated fatty acids proportion in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi* of the roast beef is shown in Table 3.

The saturated fatty acid proportion from the proportion of the total fatty acids of the intramuscular fat in the thigh and roast beef muscles was statistically evaluated according to the analysis of variance, comparing the critical value with the test characteristic, based on which the null hypothesis H_0 was rejected. The comparison result shows that the saturated fatty acid proportion from the total proportion of fatty acids of intramuscular fat in the thigh and roast beef muscles is different in the groups statistically not significant F (0.41^{-}, p >0.05). The thighs and roast beef muscles did not affect the saturated fatty acid proportion.

Table 3 Average proportion and statistical evaluation of the saturated fatty acids proportion in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi* of the roast beef.

Group	n	$\bar{x}$ ±SD, %	Scheffe´s test, α = 0.05	
			Beef thigh – *m. quadriceps femoris*	**Roast beef – *m. longissimus dorsi***
Beef thigh – *m. semimembranosus*	6	36.30 ±2.72	p >0.05	p >0.05
Beef thigh – *m. quadriceps femoris*	6	37.12 ±0.71	p >0.05	
Roast beef – *m. longissimus dorsi*	6	39.95 ±0.75		
Analysis of variance	F (0.41, p >0.05)			

Note: m. – muscle, n – multiplicity, SD – standard deviation, p >0.05 – no statistically significant difference.

The saturated fatty acid proportion from the total proportion of the fatty acids of intramuscular fat in the *m. semimembranosus* of the thigh reached the average value of 36.30%, and in *m. quadriceps femoris* of the thigh slightly higher, 37.12%. The average proportion of saturated fatty acids out of the total fatty acid proportion of intramuscular fat in *m. longissimus dorsi* of the roast beef was found to be 36.95%.

The difference in the proportion of saturated fatty acids from the total proportion of fatty acids of intramuscular fat between *m. semimembranosus* and *m. quadriceps femoris* of the thigh was not statistically significant (p >0.05). Also, the difference in the proportion of saturated fatty acids from the total fatty acid proportion of intramuscular fat between *m. semimembranosus* and *m. longissimus dorsi* of the was not statistically significant (p >0.05). But not even the difference between *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the roast beef was not statistically significant (p >0.05).

Statistical evaluation of the results of the saturated fatty acids proportion from the total proportion of fatty acids of intramuscular fat in the thigh and roast beef muscles based on the standard deviation revealed that the largest fluctuation of the measured values was at *m. semimembranosus* of the thigh and fairly balanced at *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the roast beef (SD = 2.72 vs. SD = 0.71 and SD = 0.75).

Vahmani et al. **[21]** state that intramuscular fat in bovine carcass muscle is proportionally composed of an average of 45-48% saturated fatty acids. These values are higher than our results in the intramuscular fat of the examined thigh and roast beef muscles.

Saturated fatty acids have historically been considered undesirable in the human diet **[22]**. The main saturated fatty acids in ruminant meat, which include cattle, are myristic acid (C14:0), palmitic acid (C16:0), and stearic acid (C18:0). Some saturated fatty acids (lauric acid, myristic acid, and palmitic acid) have been shown to increase cholesterol by their properties, which are an indicator of the risk of coronary heart disease **[23]**.

In general, elevated low-density lipoprotein (LDL) cholesterol is associated with a higher risk of heart / arterial disease compared to high-density cholesterol (HDL), which is protective **[24]**. The links and mechanisms between saturated fatty acids, cholesterol, and coronary heart disease are complicated and often contradictory, as individual fatty acids are associated with positive, neutral, and negative effects on heart disease **[23]**.

Forouhi et al. **[25]** found an even chain of saturated fatty acids (C14:0, C16:0, and C18:0), which were beneficial in their effects, while saturated fatty acids with an odd chain (C15:0 and C17:0) in low concentrations) were indirectly associated with the occurrence of type 2 diabetes *mellitus.* Khaw et al. **[26]** also reported that saturated fatty acids were associated with a risk of ischemic disease.

Not all fatty acids uniformly affect human health, suggesting that additional subgroups and identifying specific functions of individual fatty acids may help identify risk factors for human health **[27]**.

Monounsaturated fatty acids in the selected beef thigh and roast beef muscles

Average proportion and statistical evaluation of the monounsaturated fatty acids proportion in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi* of the roast beef is shown in Table 4.

The monounsaturated fatty acid proportion from the total proportion of the intramuscular fat fatty acids in the thigh and roast beef muscles was statistically evaluated according to the analysis of variance, comparing the critical value with the test characteristic, based on which the null hypothesis H_0 was rejected. The result of the comparison shows that the monounsaturated fatty acid proportion from the total proportion of fatty acids of intramuscular fat in the muscles of the thigh and roast beef muscles is different in the groups statistically not significant F (0.55^-, p>0.05). The thighs and roast beef muscles did not affect the monounsaturated fatty acid proportion.

Table 4 Average proportion and statistical evaluation of the monounsaturated fatty acids proportion in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi* of the roast beef.

Group	n	$\bar{x}$ ±SD, %	Scheffe´s test, α = 0.05 – Beef thigh – *m. quadriceps femoris*	Scheffe´s test, α = 0.05 – Roast beef – *m. longissimus dorsi*
Beef thigh – *m. semimembranosus*	6	48.17 ±2.89	p >0.05	p >0.05
Beef thigh – *m. quadriceps femoris*	6	49.24 ±0.62	p >0.05	
Roast beef – *m. longissimus dorsi*	6	48.44 ±1.11		
Analysis of variance		F (0.55, p >0.05)		

Note: m. – muscle, n – multiplicity, SD – standard deviation, p >0.05 – no statistically significant difference.

The monounsaturated fatty acid proportion from the total proportion of fatty acids of intramuscular fat in the *m. semimembranosus* of the thigh reached the average value of 48.17%, and in the *m. quadriceps femoris* of the thigh slightly higher, 49.24%. The average monounsaturated fatty acid proportion from the total fatty acid proportion of intramuscular fat in *m. longissimus dorsi* of the roast beef was found to be 48.44%.

The difference in the proportion of monounsaturated fatty acids from the total proportion of intramuscular fat fatty acids between *m. semimembranosus* and *m. quadriceps femoris* of the thigh was not statistically significant (p >0.05). Also, the difference in the proportion of monounsaturated fatty acids from the total proportion of fatty acids of intramuscular fat between *m. semimembranosus* of thigh and *m. longissimus dorsi* of the roast beef was not statistically significant (p >0.05). But also, the difference in the proportion of monounsaturated fatty acids from the total fatty acid proportion of intramuscular fat between *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the roast beef was not statistically significant (p >0.05).

Statistical evaluation of the results of the proportion of monounsaturated fatty acids from the total proportion of intramuscular fat fatty acids in the thigh and roast beef muscles based on the standard deviation revealed that the largest variation of the measured values was at *m. semimembranosus* of the thigh and the lowest at *m. quadriceps femoris* thigh (SD = 2.89 vs. SD = 0.62).

Vahmani et al. **[21]** report in their study a proportion of monounsaturated fatty acids of 35-45% in the intramuscular fat of mature bovine muscle, which are lower results compared to our achieved in the intramuscular fat of the thigh and roast beef.

It turned out, beef obtained from the farming system based on a diet with supplementary concentrate mixture contains monounsaturated fatty acids (with concentration and ratio) as organic/grazing-based alternatives. However, it is unclear why this difference occurs (potentially due to the supply of oleic acid from a conventional diet or de novo synthesis of oleic acid in muscle). There are no known reports of a relationship between higher monounsaturated fatty acids in conventional beef and human nutrition and health. Further research is needed in this area. Although organic meat/pastured meat has less monounsaturated fatty acids, it sometimes contains more vaccenic acid (t11 C18:1) **[28]**, leading to greater de novo synthesis of beneficial substances that can positively affect human health. However, further research is needed to assess this condition **[27]**.

Polyunsaturated fatty acids in the selected beef thigh and roast beef muscles

Average proportion and statistical evaluation of the polyunsaturated fatty acids proportion in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi of the* roast beef is shown in Table 5.

Table 5 Average proportion and statistical evaluation of the polyunsaturated fatty acids proportion in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi* of the roast beef.

Group	n	$\bar{x}$ ±*SD*, %	Scheffe´s test, $\alpha = 0.05$	
			Beef thigh – *m. quadriceps femoris*	**Roast beef – *m. longissimus dorsi***
Beef thigh – *m. semimembranosus*	6	13.37 ±0.23	p >0.05	p ≤0.05
Beef thigh – *m. quadriceps femoris*	6	13.64 ±0.16	p ≤0.05	
Roast beef – *m. longissimus dorsi*	6	14.63 ±0.59		
Analysis of variance		F (18.39, p ≤0.001)		

Note: m. – muscle, n – multiplicity, SD – standard deviation, p >0.05 – no statistically significant difference, p ≤0.001, p ≤0.05 – a statistically significant difference.

The polyunsaturated fatty acid proportion from the total proportion of intramuscular fatty acids in the thigh and roast beef muscles was statistically evaluated according to the analysis of variance, comparing the critical value with the test characteristic, based on which the null hypothesis H_0 was rejected. The comparison result shows that the proportion of saturated fatty acids from the total proportion of fatty acids of intramuscular fat in the muscles of the thigh and roast beef muscle is different in the groups statistically significant F (18.39 $^{+++}$, p ≤0.001). The thighs and roast beef muscles affected the polyunsaturated fatty acid proportion.

The polyunsaturated fatty acid proportion from the total fatty acid proportion of intramuscular fat in the *m. semimembranosus* of the thigh reached the average proportion of 13.37%, and in the *m. quadriceps femoris* of the thigh slightly higher, 13.64%. The average proportion of polyunsaturated fatty acids out of the intramuscular fat, total fatty acid proportion in *m. longissimus dorsi* of the roast beef was found to be 14.63%.

The difference in the proportion of polyunsaturated fatty acids from the total proportion of intramuscular fatty acids between *m. semimembranosus* and *m. quadriceps femoris* of the thigh was not statistically significant (p >0.05). However, the difference in the proportion of polyunsaturated fatty acids from the total fatty acid proportion of intramuscular fat between *m. semimembranosus* of the thigh and *m. longissimus dorsi* of the roast beef was statistically significant (p ≤0.05). Also, the difference in the proportion of polyunsaturated fatty acids from the total fatty acid proportion of intramuscular fat between *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the roast beef was statistically significant (p ≤0.05).

Statistical evaluation of the results of the polyunsaturated fatty acid proportion of the total intramuscular fatty acid proportion in the thigh and roast beef muscles based on the standard deviation revealed that the largest variation of the measured values was at *m. longissimus dorsi* of the roast beef and the lowest at *m. quadriceps femoris* of the thigh (SD = 0.59 vs. SD = 0.16).

Polyunsaturated fatty acid research has become very popular in human nutrition. Polyunsaturated fatty acids are categorized as having more than one double bond and most of them are divided into two main groups: omega-3 (n-3), which has a double bond between the third and fourth carbon from the terminal methyl group, and omega-6 (n-6) having a double bond between the sixth and seventh carbon from the terminal methyl group **[28]**.

The human body can metabolise and synthesise many fatty acids, but two major essential polyunsaturated fatty acids must come from the diet. These are n-3 polyunsaturated fatty acid α-linolenic acid (ALA) and n-6 polyunsaturated fatty acid linoleic acid (LA) **[29]**.

Intervention and observational studies show that replacing the saturated fatty acids in the diet with polyunsaturated fatty acids significantly reduces the risk of cardiovascular disease **[22]**, **[30]**.

The ratio of polyunsaturated to saturated fatty acids in the selected beef thigh and roast beef muscles

Average ratio and statistical evaluation of the polyunsaturated to saturated fatty acids ratio in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi of the* roast beef is shown in Table 6.

Table 6 Average ratio and statistical evaluation of the polyunsaturated to saturated fatty acids ratio in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi* of the roast beef.

Group	**n**	$\overline{x}$ ±*SD*	**Scheffe´s test, *α* = 0.05**	
			Beef thigh *– m. quadriceps femoris*	**Roast beef *– m. longissimus dorsi***
Beef thigh *– m. semimembranosus*	6	0.36 ±0.01	p >0.05	p ≤0.05
Beef thigh *– m. quadriceps femoris*	6	0.37 ±0.01	p ≤0.05	
Roast beef *– m. longissimus dorsi*	6	0.40 ±0.02		
Analysis of variance	F (15.95, p ≤0.001)			

Note: m. – muscle, n – multiplicity, SD – standard deviation, p >0.05 – no statistically significant difference, p ≤0.001, p ≤0.05 – a statistically significant difference.

The ratio of polyunsaturated fatty acids to saturated fatty acids in the intramuscular fat of the thigh and roast beef muscles was statistically evaluated according to the analysis of variance, comparing the critical value with the test characteristic, based on which the null hypothesis H_0 was rejected. The comparison result shows that the ratio of polyunsaturated to saturated fatty acids in intramuscular fat in the thigh and roast beef muscles is different in the groups statistically significant F (15.95^{+++}, p ≤0.001). The thighs and roast beef muscles affected the ratio of polyunsaturated fatty acids to saturated fatty acids.

The ratio of polyunsaturated fatty acids to saturated fatty acids of intramuscular fat in the *m. semimembranosus* of the thigh reached the average value of 0.36, and in the *m. quadriceps femoris* of the thigh slightly higher, 0.37. The average ratio of polyunsaturated fatty acids to saturated fatty acids in intramuscular fat in *m. longissimus dorsi* of the roast beef was found to be 0.40.

The difference in the values of the ratio of polyunsaturated fatty acids to saturated fatty acids in intramuscular fat between *m. semimembranosus* s and *m. quadriceps femoris* of the thigh was not statistically significant (p >0.05). But the difference in the values of the ratio of polyunsaturated fatty acids to saturated fatty acids in intramuscular fat between *m. semimembranosus* of the thigh and *m. longissimus dorsi* of the roast beef was statistically significant (p ≤0.05). Also, the difference in the values of the ratio of polyunsaturated fatty acids to saturated fatty acids in intramuscular fat between *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the was statistically significant (p ≤0.05).

Statistical evaluation of the results of the ratio of polyunsaturated fatty acids to saturated fatty acids in intramuscular fat in the thigh and roast beef muscles based on the standard deviation revealed that the largest fluctuation of values was at *m. longissimus dorsi* of the roast beef and almost half lower at *m. semimembranosus* and *m. quadriceps femoris* of the thigh (SD = 0.02 vs. = 0.01).

Vahmani et al. **[21]** interpret in their study the results of the ratio of polyunsaturated to saturated fatty acids (PUFA/SFA, P : S) as typical low in beef, about 0.1, except in very poor animals for which the ratio of polyunsaturated to saturated fatty acids may be higher, about 0.5-0.7, which is higher than our results of 0.36 and 0.37 in the bovine thigh intramuscular fat or 0.40 in the roast beef intramuscular fat.

The recommended reference value for the ratio of polyunsaturated to saturated fatty acids (PUFA/SFA or P : S) is >0.7) **[31]**. The results of our research differ from the recommended reference value of the ratio of polyunsaturated to saturated fatty acids of the mentioned authors, i.e. 0.46 for the roast beef muscle and 0.36 and 0.37 for the bovine thigh muscle.

The fatty acid composition of meat, which consists of muscle and fat tissue, is important for two reasons. Firstly, it determines the nutritional value and affects various aspects of meat quality, including shelf life and taste. The nutritional value is partly determined by the ratio of polyunsaturated to saturated fatty acids **[32]**.

The ratio of polyunsaturated to monounsaturated fatty acids in the selected beef thigh and roast beef muscles

Average ratio and statistical evaluation of the polyunsaturated to monounsaturated fatty acids ratio in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi of the* roast beef is shown in Table 7.

The ratio of polyunsaturated fatty acids to monounsaturated fatty acids in the intramuscular fat of the thigh and roast beef muscles was statistically evaluated according to the analysis of variance, comparing the critical value with the test characteristic, based on which the null hypothesis H_0 was rejected. The comparison result shows that the ratio of polyunsaturated to monounsaturated fatty acids in intramuscular fat in the thigh and roast beef muscles differs in the groups statistically significant F (12.44^{+++}, $p \leq 0.001$). The thighs and roast beef muscles affected the ratio of polyunsaturated fatty acids to monounsaturated fatty acids.

Table 7 Average value of the ratio and statistical evaluation of the ratio of the polyunsaturated fatty acids to monounsaturated fatty acids in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi* of the roast beef.

Group	n	$\overline{x}$ $\pm SD$	Scheffe´s test, α = 0.05	
			Beef thigh – *m. quadriceps femoris*	**Roast beef – *m. longissimus dorsi***
Beef thigh – *m. semimembranosus*	6	0.27 ±0.01	p >0.05	p ≤0.05
Beef thigh – *m. quadriceps femoris*	6	0.28 ±0.01	p ≤0.05	
Roast beef – *m. longissimus dorsi*	6	0.30 ±0.02		
Analysis of variance		F(12.44^{+++}, $p \leq 0.001$)		

Note: m. – muscle, n – multiplicity, SD – standard deviation, p >0.05 – no statistically significant difference, p ≤0.001, p ≤0.05 – a statistically significant difference.

The ratio of polyunsaturated fatty acids to monounsaturated fatty acids of intramuscular fat in the *m. semimembranosus* of the thigh reached the average value of 0.27, and in the *m. quadriceps femoris* of the thigh slightly higher, 0.28. The average ratio of polyunsaturated fatty acids to monounsaturated fatty acids in intramuscular fat in *m. longissimus dorsi* of the roast beef was found to be 0.30.

The difference in the values of the ratio of polyunsaturated fatty acids to monounsaturated fatty acids in intramuscular fat between *m. semimembranosus* and *m. quadriceps femoris* of the thigh was not statistically significant (p >0.05). But, the difference in the values of the ratio of polyunsaturated fatty acids to monounsaturated fatty acids in intramuscular fat between *m. semimembranosus* of the thigh and *m. longissimus dorsi* of the roast beef was statistically significant (p ≤0.05). Also, the difference in the values of the ratio of polyunsaturated fatty acids to monounsaturated fatty acids in intramuscular fat between *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the was statistically significant (p ≤0.05).

Statistical evaluation of the results of the ratio of polyunsaturated fatty acids to monounsaturated fatty acids in intramuscular fat of the thigh and roast beef muscles based on the standard deviation revealed that the largest fluctuation of values was at *m. longissimus dorsi* of the roast beef and the lowest at *m. quadriceps femoris* of the thigh (SD = 0.02 vs. SD = 0.01).

Differences in fat content affect the composition of fatty acids, regardless of the species or breed of the animal and the factors of nutrition and feeding. The content of saturated fatty acids and of monounsaturated fatty acids increases with increasing fat content faster than the content of polyunsaturated fatty acids, which leads to a decrease in the relative proportion of polyunsaturated fatty acids and consequently to changes in the ratio of polyunsaturated to saturated fatty acids (P : S) **[31]**.

For beef, there is a clear inverse relation between the ratio of polyunsaturated fatty acids to saturated fatty acids and total intramuscular fat. According to various literature sources, the ratio between beef's polyunsaturated and saturated fatty acids can fall to 0.05 for fat breeds. It can also rise to >0.5 for very lean breeds. This variation is much greater than the fact that beef's fatty acid profile is manipulated by using diet or the grazing.

In addition to the procedure of using cattle with the so-called lean meat, the only way to improve the ratio of polyunsaturated fatty acids to saturated fatty acids in ruminant meat, including cattle, is to prevent rumen bio-hydrogenation or to use feed material, feed supplements based on polyunsaturated fatty acids, respectively **[33]**.

The ratio of monounsaturated to saturated fatty acids ratio in the selected beef thigh and roast beef muscles

Average ratio and statistical evaluation of the monounsaturated to saturated fatty acids ratio in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi of the* roast beef is shown in Table 8.

The ratio of monounsaturated fatty acids to saturated fatty acids in the intramuscular fat of the thigh and roast beef muscles was statistically evaluated according to the analysis of variance, comparing the critical value with the test characteristic, based on which the null hypothesis H_0 was rejected. The comparison shows that the ratio of monounsaturated to saturated fatty acids in intramuscular fat in the thigh and roast beef muscles is different in the groups statistically insignificant F (0.36$^-$, p >0.05). The thighs and roast beef muscles did not affect the ratio of monounsaturated fatty acids to saturated fatty acids.

The ratio of monounsaturated fatty acids to saturated fatty acids in the intramuscular fat of the *m. semimembranosus* of the thigh reached the average value of 1.29, and in *m. quadriceps femoris* of the thigh slightly higher, 1.33. The mean ratio of monounsaturated fatty acids to saturated fatty acids in intramuscular fat in *m. longissimus dorsi* of the roast beef was found to be 1.31.

The difference in the values of the ratio of monounsaturated fatty acids to saturated fatty acids in intramuscular fat between *m. semimembranosus* and *m. quadriceps femoris* of the thigh was not statistically significant (p >0.05). Nor does the difference in the values of the ratio of monounsaturated fatty acids to saturated fatty acids in intramuscular fat between *m. semimembranosus* of the thigh and *m. longissimus dorsi* of the roast beef was not statistically significant (p >0.05). Also, the difference in the values of the ratio of monounsaturated fatty acids to saturated fatty acids in intramuscular fat between *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the roast beef was not statistically significant (p >0.05).

Table 8 Average ratio and statistical evaluation of the monounsaturated fatty acids to saturated fatty acids ratio in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi* of the roast beef.

Group	n	x̄ ±SD	Scheffe´s test, α = 0.05	
			Beef thigh – *m. quadriceps femoris*	**Roast beef – *m. longissimus dorsi***
Beef thigh – *m. semimembranosus*	6	1.29 ±0.09	p >0.05	p >0.05
Beef thigh – *m. quadriceps femoris*	6	1.33 ±0.04	p >0.05	
Roast beef – *m. longissimus dorsi*	6	1.31 ±0.06		
Analysis of variance		F (0.36, p >0.05)		

Note: m. – muscle, n – multiplicity, SD – standard deviation, p >0.05 – no statistically significant difference.

Statistical evaluation of the results of the ratio of monounsaturated fatty acids to saturated fatty acids in the intramuscular fat of the thigh and roast beef muscles based on the standard deviation revealed that the largest fluctuation of values was at *m. semimembranosus* of the thigh and the lowest *at m. quadriceps femoris* of the thigh (SD = 0.09 vs. SD = 0.04).

Polyunsaturated fatty acids series n-3 in the selected beef thigh and roast beef muscles

Average proportion and statistical evaluation of the polyunsaturated fatty acids series n-3 proportion in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi of the* roast beef is shown in Table 9.

The n-3 polyunsaturated fatty acid proportion from the total proportion of intramuscular fat fatty acids in the thigh and roast muscles was statistically evaluated according to the analysis of variance, comparing the critical value with the test characteristic, based on which the null hypothesis H_0 was rejected. The result of the comparison shows that the n-3 polyunsaturated fatty acid proportion of the total proportion of intramuscular fat fatty acids in the thigh and roast beef muscles is different in the groups of statistically not significant F (2.61, p >0.05). The thighs and roast beef muscles did not affect the proportion of n-3 polyunsaturated fatty acids.

The proportion of n-3 polyunsaturated fatty acids from the total intramuscular fatty acids in the *m. semimembranosus* of the thigh reached the average value of 0.57%, and in the *m. quadriceps femoris* of the thigh slightly higher, 0.58%. The average proportion of n-3 polyunsaturated fatty acids out of the total intramuscular fat fatty acid proportion in *m. longissimus dorsi* of the roast beef was found to be 0.63%.

The difference in the proportion of n-3 polyunsaturated fatty acids from the total proportion of intramuscular fatty acids between *m. semimembranosus* and *m. quadriceps femoris* of the thigh was not statistically significant (p >0.05). Nor is the difference in the proportion of the n-3 polyunsaturated fatty acids of the total proportion of intramuscular fat fatty acids between *m. semimembranosus* of the thigh and *m. longissimus dorsi* of roast beef was not statistically significant (p>0.05). Also, the difference in the proportion of n-3 polyunsaturated fatty acids from the total proportion of intramuscular fatty acids between *m. quadriceps femoris* of the thighs and *m. longissimus dorsi* of the roast beef was not statistically significant (p >0.05).

Table 9 Average proportion and statistical evaluation of the n-3 polyunsaturated fatty acid proportion in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi* of the roast beef.

			Scheffe´s test, α = 0.05	
Group	**n**	**$\bar{x}$ ±SD, %**	**Beef thigh – *m. quadriceps femoris***	**Roast beef – *m. longissimus dorsi***
Beef thigh – *m. semimembranosus*	6	0.57 ±0.05	p >0.05	p >0.05
Beef thigh – *m. quadriceps femoris*	6	0.58 ±0.05	p >0.05	
Roast beef – *m. longissimus dorsi*	6	0.63 ±0.04		
Analysis of variance	F (2.61, p >0.05)			

Note: m. – muscle, n – multiplicity, SD – standard deviation, p >0.05 – no statistically significant difference.

Statistical evaluation of the results of the proportion of n-3 polyunsaturated fatty acids from the total proportion of intramuscular fat fatty acids in the thigh and roast beef muscles based on the standard deviation revealed that the greater variation of the measured values was *m. semimembranosus* a *m. quadriceps femoris* of the thigh and lower at *m. longissimus dorsi* of the (SD = 0.05 vs. SD = 0.04).

N-3 polyunsaturated fatty acids in beef contribute significantly to the overall human n-3 polyunsaturated fatty acid intake. Currently, several brands are applied to selling beef under a strict feed feeding practice code, e.g. pasture (PCAS system in Australia) **[34]**.

Beef is a source of long-chain n-3 essential polyunsaturated fatty acids, often under-consumed in the human diet **[28]**.

Consumption of the very long-chain n-3 polyunsaturated fatty acids reduces the risk of cardiovascular disease and demonstrates reduced arrhythmia, blood pressure, inflammation, platelet sensitivity, and dementia **[35]**.

Consumption of ruminant meat could be a good method to increase the intake of n-3 polyunsaturated fatty acids **[36]**. In contrast, beef from the organic and pasture system contains more n-3 polyunsaturated fatty acids than cattle from a system based on diets with a supplementary concentrate mixture, which benefits the health of the food consumer **[28]**.

This type of meat has price advantages over similar types obtained from conventional farming. Today, consumers are looking for products from natural breeding conditions and are willing to pay more. In the context of n-3 polyunsaturated fatty acids, the health benefits of n-3 polyunsaturated fatty acids need to be more clearly defined. Further studies are needed to indicate the value offered for beef production based on the rearing system, the application of welfare principles, and the type of feed **[37]**.

Polyunsaturated fatty acids n-6 in the selected beef thigh and roast beef muscles

Average proportion and statistical evaluation of the n-6 polyunsaturated fatty acid proportion in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi* of the roast beef is shown in Table 10.

The n-6 polyunsaturated fatty acid proportion from the total proportion of intramuscular fat fatty acids in the thigh and roast muscles was statistically evaluated according to the analysis of variance, comparing the critical value with the test characteristic, based on which the null hypothesis H_0 was rejected. The result of the comparison shows that the proportion of n-6 polyunsaturated fatty acids of the total proportion of intramuscular fat fatty acids in the thigh and roast beef muscles is different in the groups statistically significant F (11.79 $^{+++}$, $p \leq 0.001$). The thighs and roast beef muscles affected the dry matter proportion and the n-6 polyunsaturated fatty acid proportion.

The proportion of n-6 polyunsaturated fatty acids from the total intramuscular fat fatty acids in the *musculus semimembranosus* of the thigh reached the average value of 12.58%, and in the *m. quadriceps femoris* of the thigh slightly higher, 12.68%. The average proportion of n-6 polyunsaturated fatty acids out of the total intramuscular fat fatty acid proportion in *m. longissimus dorsi* of the roast beef was found to be 13.99%.

Table 10 Average proportion and statistical evaluation of the n-6 polyunsaturated fatty acid proportion in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi* of the roast beef.

Group	n	$\bar{x}$ ±SD, %	Scheffe´s test, α = 0.05: Beef thigh – *m. quadriceps femoris*	Scheffe´s test, α = 0.05: Roast beef – *m. longissimus dorsi*
Beef thigh – *m. semimembranosus*	6	12.58 ±0.41	$p > 0.05$	$p \leq 0.05$
Beef thigh – *m. quadriceps femoris*	6	12.68 ±0.71	$p \leq 0.05$	
Roast beef – *m. longissimus dorsi*	6	13.99 ±0.60		
Analysis of variance		F (11.79, $p \leq 0.001$)		

Note: m. – muscle, n – multiplicity, SD – standard deviation, $p > 0.05$ – no statistically significant difference, $p \leq 0.001$, $p \leq 0.05$ – a statistically significant difference.

The difference in the proportion of the n-6 polyunsaturated fatty acids from the total proportion of intramuscular fat fatty acids between *m. semimembranosus* and *m. quadriceps femoris* of the thigh was not statistically significant ($p > 0.05$). However, the difference in the proportion of n-6 polyunsaturated fatty acids from the total proportion of intramuscular fat fatty acids between *m. semimembranosus* of the thigh and *m. longissimus dorsi* of the roast beef was statistically significant ($p \leq 0.05$). Also, the difference in the proportion of the n-6 polyunsaturated fatty acids from the total proportion of intramuscular fat fatty acids between *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the roast beef was statistically significant ($p \leq 0.05$).

Statistical evaluation of the results of the n-6 polyunsaturated fatty acid proportion of the total intramuscular fat fatty acid proportion in the thigh and roast beef muscles based on the standard deviation revealed that the greater variation of the measured values was *m. quadriceps femoris* and lower at *m. semimembranosus* of the thigh (SD = 0.71 vs. SD = 0.41).

According to the literature, there are many results on the content of n-6 polyunsaturated fatty acids from the comparison of beef obtained from the cattle breeding system in organic farming and free-range grazing in conventional rearing based on feed ration with a supplementary concentrate mixture, respectively. Some studies report increased levels of linoleic acid in beef from organic rearing **[38]** and others in conventional beef **[28]**. Importantly, in almost all publications, there is a difference in linoleic acid content between farming systems. Still, there is marginal interest in the management of cattle in each farming system, suggesting that management (and thus potential nutrition and feeding of cattle) has a very small effect on the linoleic acid content, the total concentration of n-6 polyunsaturated fatty acids in beef, respectively **[27]**.

The ratio of the n-6 polyunsaturated fatty acids to n-3 polyunsaturated fatty acids in the selected beef thigh and roast beef muscles

Average ratio and statistical evaluation of the n-6 polyunsaturated fatty acids to n-3 polyunsaturated fatty acids in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi of the* roast beef is shown in Table 11.

The ratio of n-6 polyunsaturated fatty acids to n-3 polyunsaturated fatty acids in the intramuscular fat of the thigh and roast beef muscles was statistically evaluated according to the analysis of variance, comparing the critical value with the test characteristic, based on which the null hypothesis H_0 was rejected. The result of the comparison shows that the ratio of the n-6 polyunsaturated fatty acids to n-3 polyunsaturated fatty acids of the intramuscular fat in the thigh and roast beef muscles is different in the groups statistically not significant F (0.12^-, *p* >0.05). The thighs and roast beef muscles did not affect the ratio of n-6 polyunsaturated fatty acids to n-3 polyunsaturated fatty acids.

The ratio of n-6 polyunsaturated fatty acids to n-3 polyunsaturated fatty acids of intramuscular fat in the *m. semimembranosus* of the thigh reached the average value of 22.1, and in the *m. quadriceps femoris* of the thigh slightly higher, 21.92. The mean ratio of n-6 polyunsaturated fatty acids to n-3 polyunsaturated fatty acids in intramuscular fat in *m. longissimus dorsi* of the roast beef was found to be 22.41.

Table 11 Average ratio and statistical evaluation of the n-6 polyunsaturated fatty acids to n-3 polyunsaturated fatty acids in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi* of the roast beef.

Group	n	$\overline{x}$ $\pm SD$	Scheffeho test, α = 0.05 Beef thigh – *m. quadriceps femoris*	Scheffeho test, α = 0.05 Roast beef – *m. longissimus dorsi*
Beef thigh – *m. semimembranosus*	6	22.10 ±2.35	*p* >0.05	*p* >0.05
Beef thigh – *m. quadriceps femoris*	6	21.92 ±1.24	*p* >0.05	
Roast beef – *m. longissimus dorsi*	6	22.41 ±1.40		
Analysis of variance		F (0.12, *p* >0.05)		

Note: m. – muscle, n – multiplicity, SD – standard deviation, *p* >0.05 – no statistically significant difference.

The difference in the values of the n-6 polyunsaturated fatty acids ratio to n-3 polyunsaturated fatty acids in the intramuscular fat between *m. semimembranosus* and *m. quadriceps femoris* of the thigh was not statistically significant (*p*>0.05). Nor does the difference in the values of the n-6 polyunsaturated fatty acids ratio to n-3 polyunsaturated fatty acids in the intramuscular fat between *m. semimembranosus* of thigh and *m. longissimus dorsi* of the roast beef was not statistically significant (*p* >0.05). Also, the difference in the values of the ratio of n-6 polyunsaturated fatty acids to n-3 polyunsaturated fatty acids in intramuscular fat between *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the roast beef was not statistically significant (*p* >0.05).

Statistical evaluation of the ratio of n-6 polyunsaturated fatty acids to n-3 polyunsaturated fatty acids in the intramuscular fat of the thigh and roast beef muscles based on the standard deviation revealed that the largest fluctuation of values was at *m. semimembranosus* and the lowest at *m. quadriceps femoris* of the thigh (SD = 2.35 vs. SD = 1.24).

The recommended reference value for the ratio between n-6 polyunsaturated fatty acids and n-3 polyunsaturated fatty acids is <5 **[31]**. Our research found a much wider ratio between n-6 to n-3 polyunsaturated fatty acids. The ratio between polyunsaturated fatty acids in the roast beef muscle was 22.41, and in the bovine thigh muscle, 21.92 and 22.1.

Correlations between examined variables in the musculus semimembranosus, m. quadriceps femoris of beef thigh and m. longissimus dorsi of the roast beef

The average value and statistical evaluation of the correlations between examined variables in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi* of the roast beef is shown in Table 12.

A strong linear relation positive and statistically significant (*p* ≤0.01, *p* ≤0.001) was recorded between intramuscular fat and polyunsaturated fatty acids, between intramuscular fat and the ratio of polyunsaturated to saturated fatty acids, between intramuscular fat and the ratio of polyunsaturated to monounsaturated fatty acids, between intramuscular fat and n-3 polyunsaturated fatty acids, between intramuscular fat and n-6 polyunsaturated fatty acids, also between saturated and monounsaturated fatty acids, between polyunsaturated fatty acids and the ratio of polyunsaturated to saturated fatty acids, between polyunsaturated fatty acids and the ratio of polyunsaturated to monounsaturated fatty acids, between polyunsaturated fatty acids and n-6 polyunsaturated fatty acids, also between the ratio of polyunsaturated to saturated fatty acids and the ratio of polyunsaturated to monounsaturated fatty acids, between the ratio of polyunsaturated to saturated fatty acids and n-6 polyunsaturated fatty acids, between the ratio of polyunsaturated to monounsaturated fatty acids and n-6 polyunsaturated fatty acids, but also between n-3 polyunsaturated fatty acids to n-6 polyunsaturated fatty acids.

Table 12 Average value and statistical evaluation of the correlations between examined variables in the *musculus semimembranosus* and *m. quadriceps femoris* of the beef thigh and in the *m. longissimus dorsi* of the roast beef.

Variable	Fat	SFA	MUFA	PUFA	PUFA/SFA	PUFA/MUFA	MUFA/SFA	n-3	n-6	n-6/n-3
Dry matter	0.38^{-}	0.03^{-}	0.23^{-}	-0.32^{-}	-0.35^{-}	-0.40^{-}	0.13^{-}	-0.30^{-}	-0.42^{-}	-0.02^{-}
Fat		0.04^{-}	-0.02^{-}	0.69^{++}	0.69^{+++}	0.60^{++}	0.09^{-}	0.58^{++}	0.75^{+++}	0.01^{-}
SFA			0.60^{++}	0.09^{-}	0.11^{-}	0.23^{-}	-0.41^{-}	-0.07^{-}	0.27^{-}	0.34^{-}
MUFA				-0.20^{-}	0.05^{-}	-0.25^{-}	0.23^{-}	-0.02^{-}	0.13^{-}	0.15^{-}
PUFA					0.93^{+++}	0.96^{+++}	-0.16^{-}	0.34^{-}	0.71^{+++}	0.25^{-}
PUFA/SFA						0.85^{+++}	-0.02^{-}	0.38-	0.77^{+++}	0.26^{-}
PUFA/MUFA							-0.28^{-}	0.28^{-}	0.68^{++}	0.27^{-}
MUFA/SFA								0.42^{-}	-0.09^{-}	-0.61^{++}
n-3									0.59^{++}	-0.63^{++}
n-6										0.25^{-}

Note: the numerical value is the result of r (correlation coefficient); – designation by upper index means no statistically significant difference in the correlation relation between the two variables (p >0.05); ++, +++ designation by upper index means statistically significant difference in the correlation relation between the two variables (p ≤0.01, p ≤0.001).

A strong linear relationship negative and statistically significant (p ≤0.01) was recorded between the ratio of monounsaturated to saturated fatty acids, the ratio of n-6 to n-3 polyunsaturated fatty acids, and also between n-3 polyunsaturated fatty acids and the ratio of n-6 to n-3 polyunsaturated fatty acids.

Among all other variables, a trivial or mean positive or negative linear relation was recorded as statistically insignificant (p >0.05).

It is crucial to look for healthy foods that meet consumer quality requirements while respecting the doses for the ratio of polyunsaturated fatty acids to saturated fatty acids, n-6 to n-3 polyunsaturated fatty acids set by public health authorities to prevent cardiovascular and other diseases. Fat storage and fatty acid profiles have a major impact on meat quality assessment, and their relation to human health should be made carefully and with greater scientific support. However, further studies are needed to clarify the real impact of fat and fatty acid consumption on human health **[39]**.

CONCLUSION

The presented study is current in terms of research addressing the quality of beef in terms of the fatty acid profile of the health of the food consumer. *Musculus semimembranosus* and *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of the roast beef were selected to research meat obtained from the young bull. The results led to the conclusion based on which it can be stated that between *m. semimembranosus* and *m. quadriceps femoris* of the thighs are not statistically significant differences (p >0.05) in the investigated fatty acids. Statistically significant differences (p ≤0.05) were found between *m. quadriceps femoris* of the thigh and *m. longissimus dorsi* of roast beef in polyunsaturated fatty acids, the ratio of polyunsaturated fatty acids to saturated fatty acids, and the ratio of polyunsaturated fatty acids to monounsaturated fatty acids. Strong, statistically significant (p ≤0.01, p ≤0.001) correlations were found mainly between intramuscular fat and polyunsaturated fatty acids, between intramuscular fat and the ratio of polyunsaturated fatty acids to saturated fatty acids, between intramuscular fat, and the ratio of polyunsaturated fatty acids to monounsaturated fatty acids. In conclusion, it can be stated that the muscles of the thigh and roast beef from young cattle are characterized by statistically significant differences in the proportion of fatty acids. The examined muscles meet the recommended values by the ratio of polyunsaturated fatty acids to saturated fatty acids, increasing and maintaining the health of the food consumer. Still, they pose a risk concerning cardiovascular diseases by the ratio of n-6 polyunsaturated fatty acids to n-3 polyunsaturated fatty acids.

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