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The effect of cattle breed on the quality of intramuscular fat

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Abstract: The aim of the study was to verify whether differences in intramuscular fat quality, evaluation based on fatty acid profile and ratios, occur between cattle genotypes – the combined performance cattle breed Czech Fleckvieh and the beef breed Aberdeen Angus – under identical rearing conditions (same pasture location and nutritional management) with extensive grazing. The results of observation show the difference in the quality of intramuscular fat of bulls with combined performance and bulls with meat performance in extensive pastoral farming. Breed differences were reflected by a statistically significantly higher mean intramuscular fat ($P \le 0.05$) in the beef cattle breed (149 ± 60.1 g/kg dry matter) compared to the combined performance breed (120 ± 51.8 g/kg dry matter). A higher saturated fatty acid (SFA) value of 53.4 ± 22.2 g/kg dry matter was observed in the beef cattle breed compared to SFA 40.8 ± 18.9 g/kg dry matter ($P \le 0.05$) in the combined performance cattle breed; a higher monounsaturated fatty acid (MUFA) value of 43.8 ± 26.3 g/kg dry matter compared to a MUFA value of 42.3 ± 20.8 g/kg dry matter ($P > 0.05$); and a higher value of polyunsaturated fatty acids n-3 (PUFA n-3) 0.76 ± 0.33 g/kg dry matter ($P \le 0.05$) compared to PUFA n-3 0.48 ± 0.21 g/kg dry matter in combined performance cattle breed. A higher value of polyunsaturated fatty acids n-6 (PUFA n-6) 3.66 ± 1.39 g/kg dry matter was found in the combined performance cattle breed compared to the meat cattle breed with PUFA n-6 3.54 ± 0.96 g/kg dry matter ($P > 0.05$). A more favourable n-6/n-3 PUFA ratio was observed in the Aberdeen Angus ($P \le 0.05$). The results suggest that the different genotypes of the bull breeds studied, reared on extensively used pasture, may influence the amount of intramuscular fat and its quality.

Keywords: Aberdeen Angus; Czech Fleckvieh; dietary fat; fatty acid; pasture

Grazing cattle is the most natural way to raise and feed them. The pastoral method of raising cattle brings benefits that we perceive in relation to the animal itself, the quality of animal food and the landscape. By grazing, we support the natural method of raising cattle, which, from the point of view of the animal's wellbeing, allows movement that helps the harmonious formation of its body and positively influences the animal's physiological condition. Grazing also promotes the animal's immunity by strengthening the immune system, while contact between animals is very important for their wellbeing. Grazing is important nutritionally, where it is a key source of nutrients and helps maintain a healthy digestive tract. The benefits of grazing areas for landscape sustainability and

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for the protection of valuable or even rare ecosystems should not be overlooked.

Influencing the nutritional value of pastures through their botanical composition. The botanical composition of a pasture is mainly influenced by soil and climatic conditions, interspecific plant competition or differences in grazing behaviour (Kearns et al. 2023). The botanical composition can vary considerably over the course of the year (Warda and Stamirowska-Krzaczek 2009). From a botanical point of view, grasses (*Poaceae*), supplemented by leguminosae (*Fabaceae*) and herbs, form the basis of the pasture vegetation. Leguminosis is characterised by a high crude protein content. Herbs provide a variety of mineral and specific substances that increase the palatability of the pasture. Grasses also contain significant amounts of α-tocopherol (Kearns et al. 2023). Both perennial ryegrass (*Lolium perenne*) and meadow fescue (*Festuca pratensis*) provide polyphenol oxidase, which reduces biohydrogenation of polyunsaturated fatty acids (PUFA) in the rumen (Dierking et al. 2010). It has been observed that a pasture with diverse vegetation, as compared to a monoculture pasture, can provide sufficient biomass by offering a variety of plant species and the presence of polyphenol oxidase to promote essential fatty acids, where polyphenol oxidase is thought to help in PUFA bypass, where it probably prevents lipolysis of membrane lipids (Dierking et al. 2010).

Influencing the nutritional value of pastures through their management. The selected grazing system has been observed to influence the nutritional quality of forage (Venter et al. 2019; Harmel et al. 2021; Augustine et al. 2023), where the use of continuous grazing resulted in increased live weight gains of grazing animals when compared to rotational grazing (Augustine et al. 2023). Cattle raised on continuous grazing were also found to be in better condition (Harmel et al. 2021). An appropriate management plan plays an important role in both rotational and continuous use of pastures (Venter et al. 2019; Harmel et al. 2021), where, with proper grazing management, no difference in daily live weight gain may be observed between cattle grazed continuously and those grazed in optimally scheduled rotational grazing, where the soil is allowed to recover sufficiently to ensure good forage regrowth (Venter et al. 2019).

Influencing the nutritional value of pastures through cattle behaviour. Cattle grazing behaviour, which is influenced by both individual behaviour (Neave et al. 2022; Creamer and Horback 2024), as well as environmental and management factors (Kaufmann et al. 2013; Schoenbaum et al. 2017; Riaboff et al. 2020; Augustine et al. 2023) significantly affects the efficiency of pasture use. Individual animal behaviour (Neave et al. 2022; Creamer and Horback 2024) may influence the preference for plant intake or motivation to advance into less accessible parts of the pasture and explore larger areas (Neave et al. 2022; Creamer and Horback 2024). It has been observed that calmer and more inquisitive cattle accepted grazing forage for longer periods of time compared to more excitable and fearful individuals (Neave et al. 2022; Creamer and Horback 2024). Cattle grazing behaviour is also influenced by external factors such as stocking rates, climatic conditions (Schoenbaum et al. 2017), pasture terrain, vegetation (Kaufmann et al. 2013; Schoenbaum et al. 2017), watering hole and shade location strategies (Riaboff et al. 2020) and the grazing system used (Augustine et al. 2023). It has been observed that at higher cattle densities on the pasture, animals tend to penetrate into less accessible areas (Schoenbaum et al. 2017) and move at greater distances from sources of supplementary feed and water (Rivero et al. 2021). Less selective grazing was observed under rotational grazing compared to continuous grazing (Augustine et al. 2023).

Effect of grazing on the nutritional value of beef. Increasingly, consumers of animal products are concerned about the conditions under which food animals are raised, whether their welfare is respected, and whether adequate nutrition has a positive impact on the production of safe food of animal origin (Barton et al. 2010). The quality of produced meat is influenced by a number of factors such as breed, growth rate, fattening technology and especially nutrition (Sobczuk-Szul et al. 2021; Mujic et al. 2025).

A certain physiological difference can be seen in the digestion of lipids in ruminant animals, in contrast to monogastric animals. This is also suggested by the different fatty acid composition of ruminant lipids, which differs from other mammals. We find especially unusually high stearic and oleic acids in the tissue lipids, but also in the milk fat of ruminant animals (Pesek et al. 2006; Acosta-Balcazar et al. 2022). The representation of polyunsaturated fatty acids (PUFA) in the intramuscular fat of cattle

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of different genotypes is also interesting (Subrt et al. 2006). The desired ratio of PUFA n-3/n-6 in the human diet is less than 1 : 5 (FAO/WHO 1994). In particular, it is desirable to promote higher levels of n-3 PUFAs in beef to achieve an optimal ratio of n-3/n-6 PUFAs (Corino et al. 2022). Consumption of n-3 PUFAs is thought to prevent the development of inflammatory, oncological and cardiovascular diseases (Roche 1999). It has been observed that beef from grazing cattle showed higher levels of n-3 PUFAs compared to beef from cattle reared in a more intensive way and fed concentrated feeds (Lenighan et al. 2020; Hu et al. 2021; Nogoy et al. 2022). As reported by Enser et al. (1998), the most commonly occurring PUFAs in the meat of grazing cattle are linoleic acid (C18:2n6), α-linolenic acid (C18:3n3) and long-chain fatty acids such as arachidonic acid (C20:4n6), eicosapentaenoic acid (C20:5n3), docosapentaenoic acid (C22:5n3) and docosahexaenoic acid (C22:6n3). A more appropriate ratio of linoleic acid to α-linolenic acid was observed in the meat of grazing cattle compared to that of intensively raised cattle (Siphambili et al. 2020; Hu et al. 2021; Nogoy et al. 2022). As reported by Enser et al. (1998), since beef contains lower levels of PUFAs, the aim is to achieve a more balanced ratio of PUFAs to saturated fatty acids (SFAs), which may contribute to elevated LDL-cholesterol levels. One of the most abundant SFAs in beef is palmitic acid (C16:0), which increases blood cholesterol concentrations (Khosla and Sundram 1996). Beef from grazing cattle contained higher levels of PUFA compared to meat from intensively raised cattle (Butler et al. 2021) and lower amounts of SFA (Lenighan et al. 2020; Siphambili et al. 2020; Nogoy et al. 2022).

The aim of the study was to verify whether the quantity and quality of intramuscular fat could be influenced by the different genotype of bulls with combined performance (Czech Fleckvieh) and bulls for meat (Aberdeen Angus) in an extensive grazing system.

MATERIAL AND METHODS

The studied cattle breeds were selected based on the fact that the Czech Fleckvieh (CF) was the only combined performance breed in the study area and, together with the meat breed Aberdeen Angus (AA), it was the largest group in which it was possible to obtain up to 65 muscle samples for subsequent analysis. The Czech Fleckvieh combined performance cattle breed is adaptable to different breeding conditions, allowing efficient use for reliable combined production as well as for specialised use for significant dairy or meat production; it is also suitable for non-market dairy breeding. The Aberdeen Angus meat breed is one of the most widespread meat breeds of cattle and is bred all over the world.

Breeding characteristics. The grazing area of the cattle breeds under study was located at an altitude of 828 m in the Prachatice district (South Bohemia Region, Czech Republic). The pasture was enclosed by a combination of solid and electric fencing. Water was supplied via tanks providing drinking water. Shelter and protection against adverse weather conditions were provided naturally. Conserved roughage was supplied as needed in the form of bale feed. Salt and mineral licks were freely available. The stocking rate was approximately 1 head per 2 ha. Slaughter was carried out continuously over a two-year period, taking into account slaughterhouse capacity, while maintaining the age of the bulls at 16–18 months. The cattle were raised in an extensive pastoral way. Grazing was used in both summer and winter seasons and pastures were the dominant component of the forage ration during the main grazing season (March–November). The preferred type of grazing was free grazing, based on the free movement of animals throughout the grazing area, where no major treatment was carried out. The botanical spectrum of the forage was composed of forage grasses, red fescue (*Festuca rubra*), meadow fescue (*Festuca pratensis*), smooth meadow-grass (*Poa pratensis*) and clover, with a predominance of white clover (*Trifolii albi*). Nutrition was based on grass intake. During the grazing season, the values of crude protein and fat in the pasture gradually decreased (May–July), while in August the average values increased. From May to July, there was a gradual increase in the average values of crude fibre and fibre fractions, except for acid-detergent lignin, followed by a decrease in August. The winter ration consisted of haylage, hay and straw. Table 1 gives an overview of the essential nutrients of the pasture vegetation.

Analytical methods. Grazing forage was sampled four times during the grazing season, each time from 10 sites (n = 10), and each sample was

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Table 1. Average nutrient content (g/kg), including gross energy (MJ/kg) on a fresh matter basis, in the pasture during the growing season (n = 10)

Nutrients	May (x ± SD)	June (x ± SD)	July (x ± SD)	August (x ± SD)
Dry matter	185 ± 15.4	196 ± 22.2	220 ± 16.0	190 ± 15.9
Crude protein	43.7 ± 4.32	38.9 ± 5.26	36.6 ± 5.96	47.7 ± 10.2
Fat	7.84 ± 1.00	6.09 ± 0.66	5.22 ± 0.51	5.81 ± 1.01
Crude fibre	38.9 ± 3.56	45.5 ± 7.02	48.1 ± 5.11	35.7 ± 3.02
ADF	52.1 ± 2.18	59.2 ± 6.88	65.6 ± 7.34	52.8 ± 5.48
NDF	79.5 ± 9.04	96.2 ± 16.5	104 ± 14.6	78.2 ± 7.46
ADL	13.8 ± 2.84	9.92 ± 1.18	13.3 ± 1.35	12.2 ± 2.38
NFE	74.4 ± 10.3	86.3 ± 13.7	110 ± 12.6	81.7 ± 7.50
OM	165 ± 15.4	177 ± 22.5	200 ± 15.3	180 ± 44.2
GE	3.42 ± 0.34	3.62 ± 0.42	4.00 ± 0.30	2.49 ± 1.38
Ash	20.1 ± 1.32	19.4 ± 1.48	19.9 ± 1.33	19.3 ± 1.71
Ca	0.68 ± 0.15	1.00 ± 0.16	1.68 ± 0.38	1.41 ± 0.18
P	0.86 ± 0.12	0.76 ± 0.05	0.82 ± 0.12	0.77 ± 0.15
Mg	0.53 ± 0.12	0.73 ± 0.08	0.62 ± 0.12	0.60 ± 0.10
Na	0.10 ± 0.00	0.10 ± 0.00	0.13 ± 0.05	0.04 ± 0.06
K	4.71 ± 0.82	5.45 ± 0.44	4.07 ± 0.98	4.52 ± 0.15

Mean (x) ± standard deviation (SD)

ADF = acid detergent fibre; ADL = acid detergent lignin; GE = gross energy; NDF = neutral detergent fibre; NFE = nitrogen-free extract; OM = organic matter

taken from an area of 1 m^2. From the basic chemical analyses, attention was focused on the determination of dry matter (g/kg) by drying the samples at 105 °C by weighing under prescribed conditions, and on the crude protein content (g/kg), where the nitrogen content was determined by the Kjeldahl method and multiplied by a coefficient of 6.25. Nitrogen was determined using a Buchi analyser (Centec automatika, spol. s.r.o., Prague, Czech Republic). Fat (g/kg) was determined by the extraction procedure using an Ankom XT10 Fat Analyser (O.K. SERVIS BioPro, Prague, Czech Republic). The content of crude fibre (g/kg) and fibre fractions (acid detergent fibre ADF, neutral detergent fibre NDF, acid detergent lignin ADL) was determined using an Ankom 220 Fiber Analyser (O.K. SERVIS BioPro, Prague, Czech Republic). The ash content (g/kg) was determined by weighing after incineration at 550 °C under prescribed conditions. Selected macro-elements (g/kg) were determined by atomic absorption spectrometry, Agilent Technologies, Series 240 AA (Altium International s.r.o., Prague, Czech Republic). The value of nitrogen – free extract (NFE) was expressed by calculation according to the formula: NFE (g/kg) = dry matter – (crude protein + fat + crude fibre + ash). Organic matter (OM) was expressed (g/kg) as dry matter – ash. Gross energy (MJ/kg) was determined calorimetrically with an AC 500 Calorimeter (LECO Instrumente, Plzeň s.r.o., Czech Republic).

Samples of the "top sirloin" section were collected over a two-year period from 65 Czech Fleckvieh bulls and 65 Aberdeen Angus bulls, aged 16–18 months, at the Volary slaughterhouse, ZEFA. Samples of 500 g were taken from the *musculus longissimus*, *pars thoracis* from the left half of the body, from the region of the 6th to 8th thoracic vertebrae. The obtained samples were cooled, frozen and analysed. The product is certified under the label "Šumava – Original Product®". From the analytical analyses, dry matter was determined by drying the samples at 105 °C by weighing under prescribed conditions for subsequent expression of the amount of intramuscular fat and fatty acids monitored in g/kg dry matter. Fat (g/kg dry matter) was determined by the extraction procedure using an Ankom XT10 Fat Analyser (O.K. SERVIS BioPro, Prague,

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Czech Republic). Extraction of fat from meat for FA determination was performed by hexane-isopropanol extraction (Hara and Radin 1978). Fatty acids (g/kg dry matter) intramuscular fat were determined by gas chromatography using a GC 2010 Gas Chromatograph Shimadzu instrument (Shimadzu Company, Kyoto, Japan) with an automatic injection system, flame ionization detector. In the SFA group, the analysis was focused on FAs: caprylic (C8:0), capric (C10:0), lauric (C12:0), tridecanoic (C13:0), myristic (C14:0), palmitic (C16:0), heptadecanoic (C17:0), stearic (C18:0), arachidic (C20:0), tricosanoic (C23:0) and lignoceric (C24:0). In the MUFA group, the analysis was focused on FAs: myristoleic (C14:1), *cis*-10-pentadecanoic (C15:1), palmitoleic (C16:1), *cis*-10-heptadecanoic (C17:1), oleic/elaidic (C18:1n9t + C18:1n9c), *cis*-11-eicosenoic (C20:1n9), erucic (C22:1n9) and nervonic (C24:1n9). In the n-6 group of PUFAs, the analysis was focused on FAs: linoleic/linoleic (C18:2n6c + C18:2n6t), γ-linolenic (C18:3n6), *cis*-11,14-eicosadiene (C20:2n6), *cis*-8,11,14-eicosatriene (C20:3n6), arachidonic (C20:4n6), *cis*-13,16-docosadiene (C22:2n6) and docosatetraenoic (C22:4n6). In the n-3 group of PUFAs, the analysis was focused on FAs: α-linolenic (C18:3n3), *cis*-11,14,17-eicosatrienoic (C20:3n3), *cis*-5,8,11,14,17-eicosapentaenoic (C20:5n3), *cis*-4,7,10,13,16,19-docosahexaenoic (C22:6n3) and docosapentaenoic (C22:5n3).

The n-6/n-3 PUFA ratio was determined. The atherogenic index (AI) and thrombogenic index (TI) were calculated according to Ulbricht and Southgate (1991) using the following equations: AI = (C12:O + 4 × C14:O + C16:O)/(∑ MUFA + ∑ PUFA); the thrombogenic index was expressed according to the equation TI = (C14:O + C16:O + C18:O)/(0.5 × ∑ MUFA + 0.5 × n-6 + 3 × n-3 + n-3/n-6).

Statistical analysis. The basic statistical characteristics include the number of samples (*n*), the mean (x) ± standard deviation (SD). Statistical analysis was based on the assessment of normality of the data using the Shapiro–Wilk test with Unistat v6.5 (Unistat Ltd., London, UK), where the data met the normality condition ($P > 0.05$). The difference of variances in the monitored indicators was tested using the *F*-test, following by a Student *t*-test calculation. Differences between means were evaluated at the significance level $P \leq 0.05$ as a statistically significant difference (*).

RESULTS

Fat. A difference between the average values of intramuscular fat content was observed in the muscle of the cattle breeds studied. As documented in Table 2, the mean value of intramuscular fat was 120 g/kg dry matter in the Czech Fleckvieh breed and 149 g/kg dry matter in the Aberdeen Angus breed ($P \leq 0.05$).

Saturated fatty acids (SFA). Very low levels of SFA (below 1.00 g/kg dry matter) were detected in the intramuscular muscle fat of the studied cattle breeds for C8:0, C10:0, C12:0, C13:0, C20:0, C23:0 and C24:0. As documented in Table 2, the dominant fatty acid from the SFA group was C16:0 (CF 22.4 ± g/kg dry matter, AA 32.6 g/kg dry matter, $P \leq 0.05$); C18:0 (CF 14.7 g/kg dry matter, AA 15.4 g/kg dry matter, $P > 0.05$); C14:0 (CF 2.32 g/kg dry matter, AA 3.47 g/kg dry matter, $P \leq 0.05$); and C17:0 (CF 1.07 g/kg dry matter, AA 1.38 g/kg dry matter, $P \leq 0.05$). The lower mean saturated fatty acid (SFA) content was for 40.8 g/kg dry matter in CF compared to 53.4 g/kg dry matter in AA ($P \leq 0.05$). The proportion of C16:0 of the total SFA was 54.9% in CF and 61.0% in AA. The proportion of C18:0 of the total SFA was 36.0% in CF and 28.8% in AA. The proportion of C14:0 of total SFA was 5.69% in CF and 6.50% in AA. The least represented saturated fatty acid in the muscle fat was C17:0, which accounted for 2.62% of the total SFA in CF and 2.58% in AA.

Monounsaturated fatty acids (MUFA). Very low MUFA levels (below 1.00 g/kg dry matter) were detected in the intramuscular muscle fat of the studied cattle breeds for C14:1, C15:1, C17:1, C20:1n9, C22:1n9 and C24:1n9. As documented in Table 2, the dominant fatty acid from the MUFA group was C18:1n9t (CF 38.0 g/kg dry matter, AA 35.9 g/kg dry matter, $P > 0.05$) and C16:1 (CF 2.97 g/kg dry matter, AA 5.85 g/kg dry matter, $P \leq 0.05$). The difference between the mean monounsaturated fatty acid (MUFA) content of 42.3 g/kg dry matter in CF and that of 43.8 g/kg dry matter in AA was statistically insignificant ($P > 0.05$). The proportion of C16:1 of total MUFA was 7.02% in CF and 13.4% in AA. The proportion of C18:1n9 of total MUFA was 89.8% in CF and 82.0% in AA.

Polyunsaturated fatty acids n-6 (PUFA n-6). Very low levels of PUFA n-6 (below 1.00 g/kg dry matter) were detected in the intramuscular muscle fat of the studied cattle breeds for C18:3n6, C20:2n6,

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Table 2. Fatty acid profile (g/kg dry matter) in the intramuscular fat of Czech Fleckvieh (*n* = 65) and Aberdeen Angus (*n* = 65) bulls

Parameter	Czech Fleckvieh (x ± SD)	Aberdeen Angus (x ± SD)	*P*-value
Fat	120 ± 51.8	149 ± 60.1	*
C14:0	2.32 ± 1.46	3.47 ± 1.66	*
C16:0	22.4 ± 10.5	32.6 ± 14.4	*
C17:0	1.07 ± 0.46	1.38 ± 0.57	*
C18:0	14.7 ± 7.72	15.4 ± 7.15	ns
C16:1	2.97 ± 2.04	5.85 ± 7.21	*
C18:1n9t	38.0 ± 18.8	35.9 ± 22.7	ns
C18:2n6c	3.02 ± 1.17	3.00 ± 0.88	ns
C18:3n3	0.36 ± 0.19	0.65 ± 0.32	*
SFA	40.8 ± 18.9	53.4 ± 22.2	*
MUFA	42.3 ± 20.8	43.8 ± 26.3	ns
PUFA n-6	3.66 ± 1.39	3.54 ± 0.96	ns
PUFA n-3	0.48 ± 0.21	0.76 ± 0.33	*
n-6/n-3	7.60 ± 2.36	4.60 ± 2.71	*
AI	0.71 ± 0.24	1.07 ± 0.42	*
TI	0.74 ± 0.23	1.18 ± 0.42	*

*$P \leq 0.05$; mean (x) ± standard deviation (SD)

AI = atherogenic index; MUFA = monounsaturated fatty acids; ns = not significant; PUFA = polyunsaturated fatty acids; SFA = saturated fatty acids; TI = thrombogenic index

C20:3n6, C20:4n6, C22:2n6 and C22:4n6. As documented in Table 2, the dominant fatty acid from the n-6 PUFA group was C18:2n6c (CF 3.02 g/kg dry matter, AA 3.00 g/kg dry matter, $P > 0.05$). The difference between the mean polyunsaturated fatty acid n-6 (PUFA n-6) content in CF 3.66 ± g/kg dry matter and that in AA 3.54 g/kg dry matter was statistically insignificant ($P > 0.05$). The proportion of the most abundant PUFA n-6 (C18:2n6c) of the total PUFA n-6 was 82.5% in CF and 84.7% in AA.

Polyunsaturated fatty acids n-3 (PUFA n-3). Very low levels of PUFA n-3 (below 0.10 g/kg dry matter) were detected in the intramuscular muscle fat of the studied cattle breeds for C20:3n3, C20:5n3, C22:6n3 and C22:5n3. As documented in Table 2, the dominant fatty acid from the n-3 PUFA group was C18:3n3 (CF 0.36 g/kg dry matter, AA 0.65 g/kg dry matter, $P \leq 0.05$). The difference between the mean polyunsaturated fatty acid n-3 (PUFA n-3) content in CF 0.48 g/kg dry matter and that in AA 0.76 g/kg dry matter was statistically significant ($P \leq 0.05$). The proportion of the most abundant PUFA n-3 of the total PUFA n-3 was 75.0% in CF and 85.5% in AA.

Ratio of n-6/n-3 PUFA. From a dietary point of view, the ratio of n-3 and n-6 PUFAs is important is just as important as their total content, the former being is related to the health of the human population when consuming beef. In general, the wider the ratio of PUFA n-6/n-3, the lower the dietary value of the fat, and the narrower the ratio of PUFA n-6/n-3, the more positively the muscle tissue can be evaluated from a dietary perspective. The effect of breed affiliation influenced the ratio of PUFA n-6/n-3. As shown in Table 2, the Czech Fleckvieh breed displayed a wider ratio of polyunsaturated fatty acids n-6/n-3 (7.60) compared to Aberdeen Angus cattle breed (4.60).

Atherogenic (AI) and thrombogenic (TI) index. The atherogenic index (AI) and thrombogenic index (TI) were assessed, as their values reflect the atherogenic and thrombogenic potential of the analysed fats. Atherogenic and thrombogenic potential is mainly attributable to saturated fatty acids (SFA) with a carbon chain of 12–18 carbon atoms. Atherogenic potential is reported to be due to lauric (C12:0), myristic (C14:0) and palmitic (C16:0) acids, and thrombogenic potential to my-

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ristic (C14:0), palmitic (C18:0) and stearic (C18:0) acids. The higher the AI and TI, the higher the potential for atherogenicity and thrombogenicity. Table 2 shows that both the AI (CF 0.71, AA 1.07, $P \leq 0.05$) and TI (CF 0.74, AA 1.18, $P \leq 0.05$) values of intramuscular fat in the studied cattle breeds are very low. For the studied indices (AI, TI), a statistically significantly higher ($P \leq 0.05$) mean value was demonstrated for the meat breed (AA) compared to the combined breed of cattle (CF).

DISCUSSION

Our results regarding intramuscular fat quality are in agreement with Dierking et al. (2010), who point not only to the influence of nutrition on the quality of intramuscular fat, but also to the influence of the animal's genotype, which contributes to the quality of intramuscular fat, respectively the fatty acid content of bovine muscle fat. Dinh (2006) found higher content of SFA, PUFA and a more favourable n-6/n-3 ratio in the muscle meat of grazing Angus cattle compared to Brahman cattle. Our results are in agreement with Dinh (2006), where we found slightly higher fatty acid values in the Aberdeen Angus meat breed compared to the Czech Fleckvieh combined breed, except for PUFA n-6. As reported by Scollan et al. (2006), differences in muscle fatty acid representation between breeds may be due to enzymatic activity related to gene expression and/or enzyme function, such as stearoyl CoA desaturase (delta-9-desaturase), which is related to fatty acid production. Scollan et al. (2006) highlight the need to select livestock breeds for pasture-raising that are predisposed to produce high levels of PUFAs compared to other fatty acids in order to create optimal fatty acid profiles in the animal's muscles. The effect of different cattle genotypes on the polyunsaturated fatty acid (PUFA) content of intramuscular adipose tissue of the *musculus longissimus pars thoracis* muscle of slaughter bulls was investigated by Subrt et al. (2006). The authors concluded that the age of the animals and carcass weight had no effect on the fatty acid content. Factors such as animal age and body weight did not affect the fatty acid structure. With increasing intramuscular fat content, the values of C18:3 (n-3 and n-6) and C22:5 (n-3 and n-6) decreased, as did the content of other acids belonging to PUFAs ($P < 0.01$). Similar conclusions were reached by Mujic et al. (2025). In our results, this dependence was observed only for C18:2n6c and PUFA n-6. Graham et al. (2006) investigated the effect of the sire and dam breed on the fatty acid profile of muscle and subcutaneous fat in beef cattle. Differences between breeds occurred in most fatty acids from intramuscular fat. The authors conclude that genetic differences could be exploited to produce meat with more desirable fatty acids. Petric et al. (2005) investigated the effect of the production system on the fatty acid composition of intramuscular fat of three muscles (*longissimus dorsi*, *semitendinosus*, *diaphragmae*) in Simmental bulls. The authors' team demonstrated the positive effect of grazing, where significantly lower percentages of saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA) were observed in grazing bulls, with higher percentages of polyunsaturated fatty acids (PUFA) and conjugated linoleic acid (CLA) compared to bulls fed a corn silage and concentrate-based diet. Yu et al. (2013) highlight the unbalanced n-6/n-3 PUFA ratio in fresh beef and pork from four Chinese cities (Shanghai, Nanjing, Yinchuan and Hohhot). The results obtained by the authors' team showed that the n-6/n-3 PUFA ratio is unbalanced and higher than the ratio (<5 : 1) recommended by FAO/WHO (1994). The total amount of PUFA n-3 was much lower than the required daily allowance. The authors recommend looking for possible solutions to increase the PUFA n-3 content of meat products or to provide an alternative source of PUFA n-3. For the same of comparison, our results were expressed in dry matter of the sample, and in the AA beef cattle breed the PUFA n-6/n-3 ration (4.60) was in accordance with the FAO/WHO (1994) recommendation, while the ratio (7.60) was slightly higher in the CF combined cattle breed. Mujic et al. (2025) report a higher ratio of PUFA n-3/n-6 (1 : 9.44) compared to our results. Our results confirm that there are interbreed differences in the nutritional value of muscle tissue in the studied bull breeds, where genotype contributes to the quantity and quality of intramuscular fat. The difference in the PUFA n-6/n-3 ratio is likely influenced by breed, as our results showed a higher PUFA n-6 content and, at the same time, a lower PUFA n-3 content in the CF breed compared to the AA meat breed, in which a lower PUFA n-6 content and a higher PUFA n-3 content were observed. Vazquez-Mosquera et al. (2023)

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and Pilarczyk and Wojcik (2015) are in agreement with our results, as cattle genotype affects the values of the atherogenic and thrombogenic index, thereby influencing the nutritional value of meat. Vazquez-Mosquera et al. (2023) reported that an effect of genotype on both indices was observed in the *m. longissimus thoracis*. In contrast, no effect of genotype on the atherogenic index was found in the *m. longissimus lumborum*, and the authors recommended considering differences between individual muscles, in which the values of both indices may vary. Pilarczyk and Wojcik (2015) observed an effect of breed on the atherogenic and thrombogenic index in the *m. longissimus lumborum*, with the most favourable nutritional value observed in the Simmental breed.

CONCLUSION

The nutritional value of muscle tissue is also determined by the quality of intramuscular fat, which is determined by the representation of individual fatty acids, among which there are those, especially in the group of unsaturated fatty acids (PUFA n-3, PUFA n-6), which are considered essential nutrients in terms of human and animal nutrition. Of the saturated fatty acids, which can primarily be considered an energy component of the diet, C16:0, C18:0, C14:0 and C17:0 were the most abundant in intramuscular fat. Although unsaturated fatty acids also serve as a source of energy in the diet, many of them are considered essential or functional nutrients, especially fatty acids from the PUFA group. The results suggest that the different genotypes of the Czech Fleckvieh and Aberdeen Angus breeds may influence the amount and quality of fat in muscle. Higher fat, SFA, MUFA and PUFA n-3 were observed in the specialised beef breed Aberdeen Angus, while higher PUFA n-6 were found in the combined Czech Fleckvieh cattle breed. Based on these findings, it is recommended to consider breed differences in the nutritional quality of beef muscle meat to produce higher-quality animal products with greater nutritional potential for consumers.

Conflict of interest

The authors declare no conflict of interest.

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