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Quality of beef from semi-intensively fattened heifers and bulls

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Used were 15 bulls and 15 heifers of the Black-and-White Polish Holstein-Friesian breed, semi-intensively fattened, with the aim of evaluating the effect of sex on the selected traits of quality of beef. Bulls were slaughtered at the mean age of 536.2 days and 523.1 kg body weight, and heifers at 528.7 days and 459.7 kg body weight, respectively. After slaughter and post-slaughter treatment, the carcasses were graded according to the EUROP system. Meat quality was assessed based on pH, colour, chemical composition (including fatty acid profile), and sensory and histological properties. The results obtained show that quality of beef in terms of technological properties and chemical composition, especially fatty acid profile, is higher in heifers than in bulls.

KEY WORDS: beef quality / bulls / cattle / heifers

The quality of beef begins with the fattening of slaughter animals. Of special significance is the breed, feeding method, sex of animals intended for slaughter, and preslaughter handling [Raesa *et al*. 2003, Bureš *et al*. 2006, Mach *et al*. 2008]. In European beef production, preference is given to animals of large and late-maturing breeds characterized by very good fattening performance, in particular high body weight gain, good feed conversion and high dressing percentage. These breeds can be fattened to heavy live weight without the risk of reducing carcass quality due to excessive fatness, while achieving very good dressing percentage and favourable tissue composition of the carcass.

Although breeding of beef cattle has developed in Poland in recent years, its contribution to live animal production is, and will be, very small (currently less than

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1% of the cattle population). Black-and-White cattle with a high proportion of Holstein-Friesians are the basic breed (over 85%) in the structure of beef production in Poland. In view of the breed structure of the Polish cattle population, which is also found in other countries with a similar proportion of dairy breeds, the commercial mating of dairy cows to beef bulls appears to be the most suitable method for improving beef livestock quality [Węglarz 1997, Trela *et al*. 2002, Voříšková *et al*. 2002, Bartoń *et al*. 2007].

Carcass and beef quality are significantly affected by sex of animals. Carcasses of bulls are characterized by higher lean content, lower fat and higher content of bones compared to carcasses of heifers. However, bulls' meat often has undesirable quality parameters, notably high pH and dark colour, which negatively affect its technological properties and make it less suitable for direct sale [Węglarz *et al*. 2002, Gil *et al*. 2005, Kögel 2005, Mach *et al*. 2008].

Most beef buyers are conscious consumers who purchase beef despite its high price. However, they expect its cost to be compensated by high quality parameters such as freshness, tenderness, juiciness, low fat content, high nutritive value and exquisite taste [Resurreccion 2004].

When assessing beef quality, one should consider not only its nutritive, but also functional value. Many studies concerning ruminant fats have indicated their health-promoting properties [Decker *et al*. 2000, Oprządek and Oprządek, 2003, Bartoň *et al.* 2005]. Although cattle receive plant feeds that are relatively rich in unsaturated fatty acids, they are biohydrogenated in the rumen, as a result of which their supply to the small intestine is limited. However, beef owes its specific properties to many components of beef fat such as vitamins E, D, and C, β-carotene, phospholipids, sphingomyelins, lysozyme, lactoferrin, and polyunsaturated fatty acids (CLA, AA, DHA, EPA). These are biologically active substances with anticancerous, antioxidant, immune-boosting and antibacterial properties, limiting fat deposition in the body [Decker *et al*. 2000, Harris 2001].

CLA is the strongest natural substance that inhibits or prevents from the development of cancer and shows antioxidant properties [Field and Schley 2004]. In addition, as an antioxidant, CLA prevents the oxidation of LDL-lipoproteins, thus reducing the risk of cardiovascular diseases, and stimulates immune function [Kennelly and Glimm 1998]. CLA is an intermediate product of the degradation of linolenic acid to stearic acid by anaerobic rumen bacteria. Thus, products obtained from ruminants, including cattle, are a unique source of this acid to humans.

One of the factors responsible for the incidence of several lifestyle diseases, cardiovascular in particular, is the excess of dietary n-6 PUFA accompanied by a deficiency of n-3 PUFA. As a result, their ratio in the modern human diet is much higher (10-15:1) than the optimum range of 2-4:1 [Weber 1993, Breslow 2006]. In all cells, n-6 and n-3 PUFA are components of lipids. Both types of acids often exhibit antagonistic action. The only problem with n-6 PUFA is their excess. They show unfavourable activity by blocking the function of n-3 acids, and furthermore, excess n-6 PUFA contributes to insulin-dependent diabetes and hypercholesteremia [Jump *et al*. 2006].

As a visual sensation, colour is mainly caused by the presence of pigments, but also depends on tissue composition and muscle structure. The buying decisions of beef consumers are often influenced by specific characteristics of meat. For this reason, many studies on beef quality suggest that measurements of meat pH and colour as the most important indicators of beef quality should be a standard procedure in meat plants, which is particularly important when choosing meat for maturation. These quality parameters are also considered when exporting beef carcasses and meat [Wulf and Wise 1999, Page *et al*. 2001, Gońi *et al*. 2007].

Bulls form the highest proportion (around 47%) of slaughter cattle purchased in Poland, while the proportion of live heifers (16%) in beef production is much smaller but still considerable. The remaining percentage is that of culled cows. Despite numerous studies on the quality of beef produced in Poland from different pure- and crossbreds, there is no comprehensive qualitative evaluation of beef from Holstein-Friesian cattle. The objective of this study was to assess the effect of sex on the quality traits of beef from Black-and-White Polish Holstein-Friesian heifers and bulls fattened semi-intensively to the age of about 18 months. The semi-intensive young cattle fattening is most often practiced in Poland.

Material and methods

Used were Polish Holstein-Friesian Black-and-White cattle (15 bulls and 15 heifers) fattened semi-intensively at one farm and being the offspring of three sires, equally represented in both sex groups. During fattening, animals were kept in tie stalls with automatic drinking bowls and feed troughs divisions enabling an individual feeding. Feeding was based on maize silage and meadow hay supplemented with 0.4 kg concentrate offered daily per 100 kg body weight. Rations were formulated based on the INRA system and modified with every 50 kg change in body weight. The mean age of bulls at slaughter was 536.2 days with body weight of 523.1 kg (min/max 516/528 kg). In heifers, the respective values were 528.7 days and 459.7 kg (min/max 448/469 kg).

After slaughter and after post-slaughter treatment, carcasses were graded for conformation and fat cover according to the EUROP system, and weighed.

Forty-eight hours post-slaughter, pH of *longissimus thoracis* (LT) and *semimembranosus* (S) muscles were measured using a pH STAR CPU device (Matthäus, Germany) with spearhead pH electrode. The pH meter was calibrated in buffers of pH 4.6 and 7.0. The device automatically corrected pH values, taking into account muscle temperature.

Meat colour was determined 48 h post-slaughter on a fresh cross-sectional area using a CR-310 chroma meter (MINOLTA Co., Ltd., Japan) equipped with a 50 mm measuring head, and quantified in the CIE L*a*b* colour space, where L* is the lightness of colour whose value ranges from 0 for black to 100 for perfect white, whereas a* and b* are colour coordinates: +a* – red, -a* – green, +b* – yellow, -b* – blue. The chroma meter was calibrated with a white tile (Y = 93.8, x = 0.3136, y = 0.3192).

Based on a* (red) and b* (yellow) coordinate values, saturation was calculated as C* ($C^* = \sqrt{(a^*)^2 + (b^*)^2}$) (CIE, 1986).

Samples weighing about 400 g were taken from the muscles and packed into separate plastic bags, which were transported to a laboratory in an ice thermoinsulated container. Basic chemical composition of the meat was determined using standard procedures [AOAC 1995].

Samples of meat (LT) for histological examination were frozen in liquid nitrogen (-80°C), and cut into serial sections 10 μm thick on a cryostat (Slee MEV, Germany) at -25°C. To identify three types of muscle fibres (I – red fibres of high enzymatic activity, IIA – intermediate fibres of medium enzymatic activity, and IIB – white fibres of low enzymatic activity), the reaction of myosin ATPase activity was carried out at pH 4.37 and pH 10.4 [Brooke *at al*. 1970]. The percentage of different muscle fibre types was estimated in a Nikon E600 light microscope. Cross-sectional area (CSA) was calculated using MultiScanBase 98 software.

After a 7-day maturation period, muscle samples were thermally treated at 165°C and at an internal temperature of 78°C. Thermal loss was determined based on muscle weight loss, while tenderness by measuring shear force (kg/cm^2) using a tenderness meter (Bydgoskie Zakłady Piekarnicze, Poland). Sensory traits were assessed by a panel of 5 tasters trained in quality control, in accordance with the principles given by Baryłko-Pikielna [1975].

In addition, in minced and homogenized samples of LT the profile of fatty acids (%) was determined with a TRACE GC ULTRA gas chromatograph (Chroma-Card) using the analytical procedures of lipid extraction from meat according to Folch [1957] and esterification according to AOAC [1995]. Methyl esters of fatty acids were separated by gas chromatography with flame ionization detection (FID), column SUPELCOWAX 10 (30 m × 0.53 mm × 1.0 um mikrometr). Separation conditions were: helium as carrier gas, 2.5 ml/min; injector temperature 220°C, column temperature 200°C, detector temperature 250°C.

The results were verified statistically with one-way analysis of variance using SAS statistical package. Significant differences between the means for sex groups were identified using the F test.

Results and discussion

Table 1 presents the slaughter value indicators. Bulls were characterized by higher preslaughter weight than heifers ($P<0.01$). Almost 30 kg heavier carcasses ($P<0.01$) were obtained from bulls. Moreover, heifers showed slightly higher dressing percentage ($P<0.01$). Most carcasses of bulls and heifers were graded using the EUROP classification as conformation class O+ and fatness class 2, with small differences between the sex groups. Evaluation of marbling in the cross-section of LT, conducted on a 9-point scale, showed practically no marbling in bulls (2.43) and slight marbling in heifers (3.38), with no significant differences between sexes. Dressing percentage

Table 1. Means and standard deviations (SD) for slaughter parameters in bulls and heifers

Item	Bulls		Heifers		Significance of difference
	mean	SD	mean	SD	
Weight at slaughter (kg)	523.1	2.8	459.7	5.5	xx
Age at slaughter (days)	536.2	1.9	528.7	2.1	ns
Weight of carcass (kg)	274.6	1.7	245.0	3.1	xx
Dressing percentage, cold (%)	52.5	0.1	53.3	0.2	xx
Carcass conformation (1-15 points)	5.71	0.87	5.64	0.93	xx
Carcass fat cover (1-5 points)	1.64	0.34	2.15	0.31	xx
Marbling (1-9 points)	2.43	0.47	3.38	1.01	ns

Carcasses classification was 15 for class E+ and 1 for class P-
ns – not significant; xx – P<0.01.
Marbling was scored with a 9-point scale: 1– devoid, 2 – practically devoid, 3 – traces, 4 – slight, 5 – small, 6 – modest, 7 – moderate, 8 – slightly abundant, and 9 – moderately abundant.

in bulls indicates that their slaughter weight was too low and they were not completely ready for slaughter, as was also shown by scores for carcass conformation, carcass fatness, and low marbling. According to Oprządek *et al*. [2007], Holstein-Friesian bulls show best carcass quality parameters when slaughtered at 600-700 kg body weight. Litwińczuk *et al*. [2006a] and Młynek *et al*. [2006] confirmed that an increase in the slaughter weight of heifers and bulls is accompanied by improved carcass conformation class and higher dressing percentage.

Table 2 presents the chemical composition of meat. Around 2.5-3% per cent points higher water content was characteristic of the muscles of bulls compared to heifers (P<0.01). Protein content was slightly higher in LT than in S muscle from both bulls and heifers, with no significant difference between sexes. Meanwhile, Daszkiewicz and Wajda [2000] found protein content to be higher of meat from heifers than from bulls.

Table 2. Means and standard deviations (SD) for basic chemical components determined in two muscles of bulls and heifers

Item	Bulls		Heifers		Significance of difference
	mean	SD	mean	SD	
Musculus longissimus thoracis					
water (%)	74.53	0.96	71.46	1.97	xx
crude protein (%)	22.26	0.64	22.37	1.04	ns
ether extract (%)	1.89	0.47	4.73	2.55	xx
Musculus semimembranosus					
water (%)	74.81	0.99	72.27	1.05	xx
crude protein (%)	21.12	0.57	21.14	1.04	xx
ether extract (%)	1.80	0.46	3.90	1.03	xx

ns – not significant; xx – P<0.01.

An important advantage of beef, which at the same time influences its dietetic value and taste is fat content. Highly significant (P<0.01) differences between bulls and heifers for this trait were found in both muscles analysed. Based on the EUROP classification, almost all of the studied animals were graded as fatness class 2, possibly suggesting a similar content of intramuscular fat of meat from heifers and bulls. The fact that meat from heifers contained more intramuscular fat than that from bulls, as indicated by chemical analysis, suggests that EUROP carcass fatness classification is inconsistent with intramuscular fat content. The subjective nature of the visual appraisal of fatness using the EUROP system was indicated by Gil *et al*. [1996]. Statistically higher dry matter and intramuscular fat content of the muscles from Polish Friesian heifers compared to bulls was also reported by Daszkiewicz and Wajda [2000], Florek and Litwińczuk [2002], Florek *et al*. [2007] and Litwińczuk *et al*. [2006b].

Table 3. Means and standard deviations (SD) for physical traits of two muscles in bulls and heifers

Item	Bulls		Heifers		Significance of differences
	mean	SD	mean	SD	
Musculus longissimus thoracis					
tenderness (kg/cm^2)	6.14	0.69	5.52	1.51	xx
PH	5.87	0.43	5.51	0.31	xx
thermal loss (%)	23.53	8.79	32.11	7.89	x
CIE L*	34.51	0.87	37.67	2.11	xx
CIE a*	15.15	0.89	17.67	1.99	xx
CIE b*	3.69	2.66	4.71	1.39	xx
C*	15.59	1.34	18.29	1.68	xx
Musculus semimembranosus					
tenderness (kg/cm^2)	7.34	0.89	6.42	0.91	x
PH	5.91	0.47	5.53	0.37	xx
thermal loss (%)	27.04	5.95	33.87	4.06	x
CIE L*	34.59	2.48	38.86	2.11	xx
CIE a*	16.18	1.29	18.10	1.69	xx
CIE b*	4.16	1.52	5.89	0.55	x
C*	16.71	0.93	19.03	2.17	xx

x – P<0.05, xx – P<0.01.

Results of physical examination of muscles are shown in Table 3. The meat from LT and S muscles was less tender in bulls (6.14 and 7.34 kg/cm^2) than in heifers (5.52 and 6.42 kg/cm^2, respectively), with significant differences between the sexes. Better tenderness of meat from heifers compared to bulls must have been influenced by the higher content of intramuscular fat and the smaller diameter of muscle fibres.

Choat *et al*. [2006] found slightly higher tenderness of meat from steers than from heifers when comparing the quality of their beef. Daszkiewicz and Wajda [2000] reported better tenderness of meat from bulls compared to heifers, but indicated that it could have been affected by the higher pH of meat from the bulls. Meanwhile, Daszkiewicz *et al*. [2005] found the increase in intramuscular fat content of meat from heifers to be accompanied by improved palatability, juiciness and tenderness.

Meat from bulls and heifers differed significantly (P<0.05) in thermal loss for both muscles under analysis; the higher loss in heifers (8.58 and 6.83%) could be ascribed to the higher content of intramuscular fat in this group.

For both analysed muscles, mean pH of meat from bulls 48 h *post-mortem* was evidently high (5.87 and 5.91) and exceeded normal values. Mean pH of meat from heifers was about 5.5 and differed highly significantly from that found in bulls. Generally, meat from bulls has higher pH values compared to that from heifers, resulting in a higher frequency of DFD meat in the former [Mach *et al*. 2008, Węglarz, 2009].

The higher pH of meat from bulls compared to that of heifers is associated with its darker colour. Consumers pay considerable attention to this characteristic of beef. As a visual sensation, colour is mainly caused by the presence of pigments, but also depends on tissue composition and muscle structure. Statistically lower L* values of meat from bulls compared to meat from heifers are suggestive of its darker colour. Lower values of colour coordinates (redness a*, yellowness b*) were obtained for meat from bulls than from heifers. Also the colour saturation values (C*) were higher for both muscles from heifers (P<0.01) Significant differences between sexes occurred within all colour characteristics.

Table 4 gives the results of sensory evaluation of the meat. Higher values for aroma intensity for both muscles analysed were found in bulls, significantly different

Table 4. Means and standard deviations (SD) for results of sensory evaluation of two muscles in bulls and heifers

Item	Bulls		Heifers		Significance of difference
	mean	SD	mean	SD	
Musculus longissimus thoracis					
aroma intensity	4.69	0.18	4.06	0.44	xx
aroma desirability	4.04	0.49	3.79	0.32	ns
tenderness	3.61	0.26	3.70	0.32	ns
juiciness	3.93	0.25	4.67	0.38	xx
taste intensity	3.89	0.38	3.98	0.37	ns
taste desirability	3.46	0.26	3.89	0.29	xx
Musculus semimembranosus					
aroma intensity	4.49	0.22	4.14	0.45	xx
aroma desirability	3.85	0.43	3.87	0.33	ns
tenderness	3.45	0.26	3.77	0.33	x
juiciness	4.02	0.25	4.47	0.39	xx
taste intensity	3.72	0.35	3.86	0.39	ns
taste desirability	3.31	0.25	3.97	0.30	xx

Each quality trait was scored with a scale from 1 to 5 using the following quality grades: 1.00-1.50 – disqualifying, 1.51-2.50 – poor, 2.51-3.50 – fair, 3.51-4.50 – good, 4.51-5.00 – very good.
x – P<0.05; xx –P<0.01; ns – not significant.

from heifers. No significant differences were identified between the sexes for aroma desirability. Meat sensory tenderness, confirmed the results obtained mechanically. Compared to meat from bulls, the heifers' meat occurred slightly more tender, which must have been related to the higher content of intramuscular fat. However, significant (P<0.05) differences only occurred for S muscle. Better juiciness was also characteristic of the muscles of heifers, with highly significant (P<0.01) differences between sexes. With regard to aroma intensity and desirability, meat from bulls was inferior to meat from heifers, but the only significant differences were found for aroma desirability. In their study concerning the effect of gender on sensory quality of meat, Choat *et al*. [2006] did not find clear differences between steers and heifers. For most sensory traits analysed, Daszkiewicz and Wajda [2000] obtained better scores for meat from bulls than from heifers. Other authors, however, reported better sensory quality of meat from heifers [Węglarz *et al*. 2002, Florek and Litwińczuk 2002].

Table 5. Means and standard deviations (SD) for percentage and diameter of muscle fibres in the *longissimus thoracis* muscle

Item	Bulls		Heifers		Significance of difference
	mean	SD	mean	SD	
Percentage of fibres					
Red fibres (I)	36.14	1.11	35.31	0.49	ns
Intermediate (IIA)	12.35	0.35	13.73	0.40	x
White fibres (IIB)	51.51	0.74	50.96	0.66	ns
Diameter of fibres (μm)					
Red fibres (I)	40.43	0.87	38.11	0.74	xx
Intermediate (IIA)	42.96	0.77	39.24	0.97	xx
White fibres (IIB)	49.97	1.17	42.05	0.59	xx

x – P<0.05; xx – P<0.01; ns – not significant.

The results of histological evaluation of LT, determined by percentage of fibres and their area, are presented in Table 5. No significant differences were identified between the sexes in per cent of red and white fibres. A slightly higher content of type IIA fibres (intermediate) was found in heifers than in bulls (P<0.05). All fibre types had a higher diameter in bulls than in heifers. Differences between the sex groups proved highly significant for this trait. Deterioration in meat tenderness is associated with the increasing diameter of muscle fibres, which is supported by the present study. The meat from bulls was characterized by poorer tenderness both mechanical and sensory Młynek *et al*. [2007] found that muscle fibre area highly and positively correlated with the age of slaughtered animals and quality of their carcasses classified according to the EUROP system. According to Hocquette *et al*. [2006], differences in the level of intramuscular fat and the proportion of different muscle fibres may lead to differences in both beef colour and thermal loss, and may also determine meat aroma and tenderness.

Table 6 presents the profile of fatty acids determined in the LT muscle. The meat from bulls differed significantly from that of heifers in the per cent share of every

Table 6. Fatty acid profile of the *longissimus thoracis* muscle (% of the sum)

Item	Bulls		Heifers		Significance of difference
	mean	SD	mean	SD	
$C_{14:0}$	1.52	0.83	2.51	0.43	xx
$C_{14:1}$	0.53	0.43	0.96	0.19	xx
$C_{15:0}$	0.56	0.12	0.36	0.07	xx
$C_{16:0}$	18.67	3.43	23.38	1.94	xx
$C_{16:1}$	2.54	1.73	5.03	0.39	xx
$C_{17:0}$	1.09	0.23	0.82	0.20	xx
$C_{17:1}$	1.03	0.14	0.90	0.14	xx
$C_{18:0}$	15.42	2.92	12.42	2.33	xx
$C_{18:1}$	27.66	7.04	39.35	3.81	xx
$C_{18:2\ n\text{-}6}$	9.46	3.78	3.19	2.40	xx
$C_{18:3\ n\text{-}3}$	1.72	0.63	0.90	0.38	xx
CLA	0.23	0.11	0.32	0.06	xx
$C_{20:0}$	0.16	0.05	0.10	0.03	xx
$C_{20:1}$	0.23	0.07	0.28	0.05	xx
$C_{20:2}$	0.23	0.13	0.08	0.12	xx
$C_{20:3}$	0.79	0.35	0.39	0.28	xx
$C_{20:4n\text{-}6}$	3.52	1.72	1.13	1.31	xx
$C_{20:4n\text{-}3}$	0.23	0.13	0.17	0.06	x
$C_{20:5n\text{-}3}$	0.84	0.48	0.49	0.34	xx
$C_{22:4n\text{-}6}$	0.31	0.14	0.11	0.11	xx
$C_{225n\text{-}3}$	1.59	0.75	0.66	0.56	xx
ΣSFA	37.43	3.95	39.59	3.76	xx
ΣUFA	50.83	2.51	53.67	2.67	x
ΣMUFA	31.98	4.03	46.51	5.30	xx
ΣPUFA	18.85	5.45	7.16	5.16	xx
ΣUFA/SFA	1.38	0.21	1.37	0.19	ns
ΣMUFA/SFA	0.86	0.08	1.18	0.14	xx
ΣPUFA/ΣSFA	0.52	0.21	0.19	0.17	xx
Σn-6	13.29	3.75	4.43	2.89	xx
Σn-3	4.37	1.30	2.23	1.86	xx
n-6/n-3 PUFA ratio	3.06	0.19	2.38	0.99	xx

SFA – saturated fatty acids, MUFA – monounsaturated fatty acids, PUFA – polyunsaturated fatty acids, UFA – unsaturated fatty acids.
x – $P<0.05$; xx – $P<0.01$; ns – not significant.

fatty acid in the sum of acids. Fat from the muscle of bulls was characterized by a significantly greater sum of polyunsaturated fatty acids (PUFA) and a lower sum of SFA, UFA and MUFA compared to fat from heifers, which is attributable to the higher intramuscular fat content of meat from heifers. Similar relations were reported by Florek *et al*. [2007].

De Smet *et al*. [2002] demonstrated that an increase in carcass fatness was paralleled by an increased content of SFA and MUFA, and a decreased content of PUFA in meat.

From among the fatty acids determined, it is worth noting the level of biologically active acids. A higher level of CLA was characteristic of the meat from heifers compared to that from bulls. Bartoň *et al*. [2005] also obtained significantly higher CLA content in heifers' than in bulls'meat.

Also, a higher level of EPA ($C_{20:5n-3}$) was found in meat from heifers than from bulls (P<0.01) and meat from bulls contained a higher level of DPA (C_{225n-3}) compared to meat from heifers (P<0.01). Bartoň *et al*. [2005] did not find any differences between the sexes in the level of these acids. Eicosanoids produced from EPA have antithrombotic and anti-inflammatory properties; they limit carcinogenesis and excessive contractibility of blood vessels.

Slightly higher SFA content in the present study was characteristic of the meat from heifers (P<0.01). As SFA considerably inhibit the conversion of n-6 acids and thus improve the general level of essential fatty acids in the body, their effect on the incidence of cardiovascular diseases is considered minimum [Griffin and Zampelas 1995]. In the present study, total PUFA sum (both n-6 and n-3) in meat from bulls was much greater than in meat from heifers, but the n-6 to n-3 PUFA ratio is to be considered optimum in both groups. As far as human dietetics is concerned, more favourable n-6/n-3 ratio was found in meat from heifers (2.38:1) compared to that from bulls (3.06:1).

Based on the results presented here, both in terms of technological suitability and chemical composition, and especially the profile of fatty acids, it is concluded that beef of higher quality can be obtained from heifers than from bulls.

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