The influence of commercial type of steers on carcass and beef meat quality parameters

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Abstract

The aim of this study was to evaluate the effect of steer breeds on carcass quality traits and selected indicators of nutritional quality (dry matter content, intramuscular fat content, protein content, ash content and meat colour parameters). A total of 27 steers were included in the experiment – 10 purebred Czech Fleckvieh (C) steers, 8 Czech Fleckvieh x Galloway (Ga) crossbreeds and 9 Czech Fleckvieh x Charolais (Ch) crossbreeds. The selected parameters were evaluated in dependence on the breed of steers. From the viewpoint of the carcass quality, it is more advantageous for breeders to use Czech Fleckvieh x Charolais crossbreeds, or to rear purebred Czech Fleckvieh steers. Significant differences ($p < 0.05$) in beef meat nutritional parameters were found only in intramuscular fat content between C × Ga steers and the other two groups. A statistically significant difference ($p < 0.05$) in the colour of beef meat was found in beef colour intensity between C × Ga crossbreeds and the other steer groups. Beef with the lightest colour came from C × Ch crossbreeds.

Beef meat, carcass, CIELab system, steers

Introduction

Cattle breeding is an inherent part of Czech agriculture. The dominant position held by cattle results from the fact that they are the world's primary producer of milk, while the rearing of cattle for meat production is also important. A significant proportion of the domestic market is made up of Czech Fleckvieh cattle which are either reared as purebred or used for commercial crossbreeding with specialized beef cattle breeds by a number of breeders in order to enhance the effectiveness of the fattening of slaughter animals and beef meat production. In comparison with other countries, steers play a less important role in meat production in the Czech Republic. Meat yields from steers have been studied by a number of authors, e.g. Boakye and Mittal (1996), Page et al. (2001), Chambaz et al. (2003) and Purchas and Zou (2008), who have compared indicators of carcass value and meat quality including the presence of intramuscular fat in steers of four breeds – Angus (A), Simmental (Si), Charolais (Ch) and Limousine (Li). Indicators of fattening capacity and carcass value were significantly influenced by the choice of breed and age at slaughter ($p > 0.05$). Angus steers reached slaughter weight after a shorter period of fattening (381 days) than steers of the other tested breeds (499, 513 and 594 days, respectively). The longest period of fattening was recorded in Limousine steers. A significant difference was also demonstrated when a comparison of average daily weight gains was made between Li steers (1.03 $kg \cdot day^{-1}$) and the other groups (A: 1.30 $kg \cdot day^{-1}$, Si: 1.18 $kg \cdot day^{-1}$ and Ch: 1.22 $kg \cdot day^{-1}$). Laborde et al. (2001) evaluated the meat from steers crossbred with Simmental (Si) and Red Angus (RA) breeds. Highly significant differences ($p < 0.01$) were found between Si and RA steers in terms of slaughter age (498.5 and 425.9 days, respectively), live weight (659.3 and 505.2 kg, respectively) and carcass weight (405.1 and 293.8 kg, respectively). No statistically significant differences between the groups were found in the amount of intramuscular fat in the sirloin (Si: 5.73%, RA: 4.37%).

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Meat colour depends mainly on the concentrations of haem pigments, particularly myoglobin and, to a lesser extent, haemoglobin. Meat colour is also influenced by the degree of marbling and livestock management and nutrition. Furthermore, meat colour is also influenced by the temperature, relative meat humidity and ambient light (Šubrt 2004). Vieira et al. (2007) reported the following values in their study: lightness (L*) 38.49, proportion of red (a*) 17.73 and proportion of yellow (b*) 6.80 in the meat of Limousine steers.

The aim of the present study was to evaluate the influence of steer breed on quality traits of carcasses and beef meat under domestic breeding conditions.

Materials and Methods

Totally 27 steers were selected for the experiment – 10 purebred Czech Fleckvieh steers (C), 9 C x Charolais crossbreeds (Ch) and 8 C x Galloway crossbreeds (Ga). Samples of the *musculus longissimus lumborum et thoracis* were taken from the site of the halving cut at the level of the 9th and 10th thoracic vertebrae and were analysed 48 hours *post mortem*.

Selected qualitative nutritional indicators were determined in beef meat: dry matter content, ash content, protein content by the Kjeldahl method, and intramuscular fat content according to Soxhlet (Czech National Standard 57 0185, 1963 – arbitration methods). The following colour indicators were also monitored in the meat: content of muscle pigments by Hornsey (1956), remission using a Spekol 11 with an adapter (Carl Weiss Jena, Germany) at a wavelength of 522 nm; parameters in the colour system CIELab were also monitored in terms of lightness (L*), redness (a*) and yellowness (b*) determined by a Konica Minolta CM – 2600d spectrophotometer (Konica Minolta, Japan). A measuring slit of 8 mm, light source daylight – D65, 10° standard observer angle and SCI mode were all set to ensure standard measurement conditions. The value of pH48 determined by a 340 pH-meter with a piercing-tipped electrode was a supplementary indicator measured. The indicators monitored were evaluated in dependence on the individual breed of steers.

Statistical evaluation was performed in the program STATISTICA 10.0 using one-way ANOVA with breed as the fixed effect (PLi). The statistical significance of differences was determined by an HSD test. The equation for the calculation was:

$$Y_{ij} = \mu + PL_i + e_{ij}$$

where:
Y – the resultant corrected value
μ – the average value of the dependent variable
PL_i – the breed of steers (Czech Fleckvieh, Galloway, Charolais)
e_{ij} – residual

Results and Discussion

The steers were slaughtered at a weight ranging from 572 kg (C × Ga) to 624 kg (C), with the net weight gain during the fattening period ranging from 489 g·day^{-1} (C × Ga) to 558 g·day^{-1} (C × Ch). The C steers had an average daily weight gain of 532 g·day^{-1}. The mean age of the steers at slaughter (Table 1) ranged from 622 days (C x Ga) to 667 days (C x Ga). The lowest carcass weight was found in the C x Ga group of steers (321 kg). The difference in carcass weight between C steers and C x Ch crossbreeds was only 4 kg (350 and 346 kg, respectively). The conformation of steers from all the groups was classified as R, and carcass classification according to fat content ranked them in quality Class 2 without significant differences between them. Ellies-Oury et al. (2012) are the only authors who have reported a fat content in Class 3 in carcasses of Charolais steer slaughtered 10 months later than the steers in our experiment.

Selected nutritional quality indicators of the steer meat are shown in Table 2 and Fig. 1. The dry matter content ranged from 25.05 to 26.12%. The lowest dry matter content was found in C × Ga crossbreeds (25.05 ± 1.14%). Ellies-Oury et al. (2012) published a dry matter content of 26.2% in the meat of Charolais steers slaughtered at an older age than the steers in our study. The protein content in steer meat was similar in all groups, with an average protein content of 21.40 ± 0.64%. No statistically significant

Table 1. Age of animals at slaughter and slaughter meat indicators by commercial type of steers

Indicator		C n = 10	C x Ga n = 8	C x Ch n = 9	Total n = 27
Age at slaughter [days]	LSM	664	667	622	651
	SE	45.70	76.56	34.45	55.73
Carcass weight [kg]	LSM	350	321	346	340
	SE	42.77	46.80	37.51	42.67
SEUROP	LSM	4.00	3.88	4.00	3.96
Conformation [score] *	SE	0.00	0.35	0.50	0.34
SEUROP	LSM	2.30	2.25	2.11	2.22
Fatness [score] **	SE	0.68	0.46	0.33	0.51

*Conformation: S = 1 to P = 6 points; **Fatness: 1 = 1 to 5 = 5 points
C – Czech Fleckvieh breed; C x Ga – Czech Fleckvieh and Galloway crossbreed; C x Ch – Czech Fleckvieh and Charolais crossbreed; LSM – Least Squares Means; SE – Standard Error

Table 2. Indicators of the nutritional value of meat by commercial type of steers

Indicator		C n = 10	C x Ga n = 8	C x Ch n = 9	Total n = 27
Dry matter [%]	LSM	26.12	25.05	25.80	25.71
	SE	1.43	1.14	0.58	1.16
Ash [%]	LSM	1.10	1.10	1.09	1.10
	SE	0.06	0.03	0.03	0.05
Proteins [%]	LSM	21.47	21.47	21.26	21.40
	SE	0.83	0.41	1.63	0.64
Intramuscular fat [%]	LSM	3.09 ^{a}	2.11 ^{b}	3.16 ^{a}	2.83
	SE	1.57	1.09	0.64	1.23

Statistical significance between groups of steers studied: a, b = $p < 0.05$; C – Czech Fleckvieh breed; C x Ga – Czech Fleckvieh and Galloway crossbreed; C x Ch – Czech Fleckvieh and Charolais crossbreed; LSM – Least Squares Means; SE – Standard Error

differences in certain meat quality indicators (the content of dry matter, ash and protein) were demonstrated between the steer groups studied ($p > 0.05$). This means that the values were highly similar. The intramuscular fat content (IMF) in sirloin ranged, in relative values, from 2.11 to 3.16%. A significant difference at the 95% level was found between C x Galloway crossbreeds (2.11 ± 1.09%) and the groups of C x Charolais crossbreeds (3.16 ± 0.64%) and Czech Fleckvieh steers (3.09 ± 1.57%). An intramuscular fat content value in Charolais steers very similar to our results (3.25%) has been published by Chambaz et al. (2003).

Indicators of muscle colour and pH_{48} values of the steers are given in Table 3 and Fig. 2. The pH_{48} value varied within a very narrow range from 5.47 to 5.50, and was not influenced by steer breed. In terms of muscle pigment content, the meat of Ch crossbreeds was evaluated as lighter in colour (3.77 $mg \cdot g^{-1}$). A statistically significant difference ($p < 0.05$) was demonstrated between the group of Ch crossbreeds and the groups of Ga crossbreeds (4.48 $mg \cdot g^{-1}$) and the dual-purpose steer breed (4.42 $mg \cdot g^{-1}$). The same trend in meat colour is indicated in the results of the study by Thénard et al. (2006),

who found myoglobin and haemoglobin iron contents ranging from 19.6 to 20.6 µg Fe·g^{-1} of muscle tissue in the meat of steers of two dairy breeds with a similar fattening weight as in our experiment (average carcass weight of around 350 kg). Dračková et al. (2010) reported a muscle pigment value of 4.1 mg·g^{-1} in the meat of Czech Fleckvieh steers.

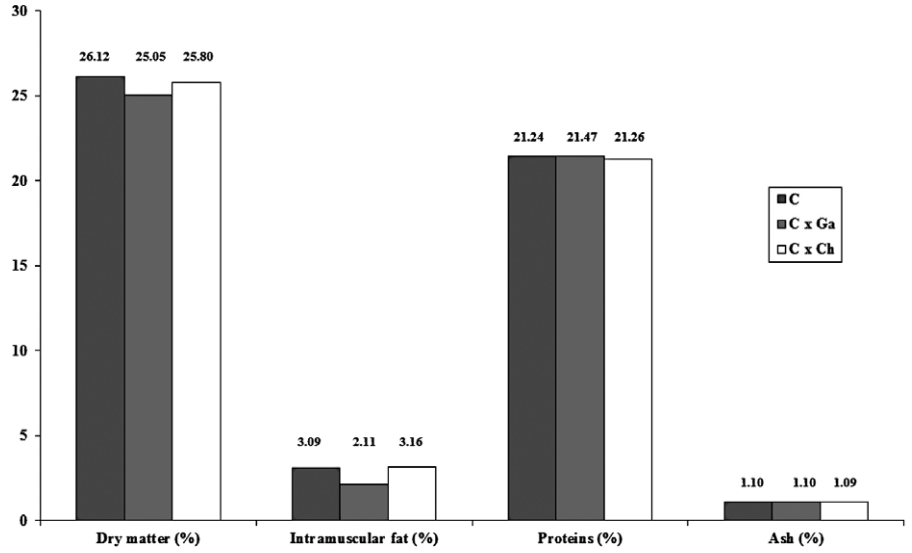

Fig. 1. Indicators of the nutritional value of meat by commercial type of steers
(C – Czech Fleckvieh breed; C x Ga – Czech Fleckvieh and Galloway crossbreed; C x Ch – Czech Fleckvieh and Charolais crossbreed)

Table 3. The pH value and indicators of muscle colour by commercial type of steers

Indicator		C n = 10	C x Ga n = 8	C x Ch n = 9	Total n = 27
pH_{48}	LSM	5.47	5.49	5.50	5.49
	SE	0.04	0.05	0.05	0.05
Pigments [mg·g^{-1}]	LSM	4.42^{a}	4.48^{a}	3.77^{b}	4.22
	SE	0.66	0.77	0.60	0.74
Remission [%]	LSM	4.94^{a}	5.03^{b}	4.93^{a}	4.96
	SE	1.78	1.32	0.90	1.35
L*	LSM	35.79^{a}	35.60^{a}	37.19^{b}	36.20
	SE	2.56	1.97	1.16	2.06
a*	LSM	11.59	11.83	11.73	11.71
	SE	1.56	1.79	2.25	1.81
b*	LSM	9.03	9.51	9.67	9.39
	SE	2.02	1.60	1.20	1.62

Statistical significance between groups of steers studied: a, b = $p < 0.05$; C – Czech Fleckvieh breed; C x Ga – Czech Fleckvieh and Galloway crossbreed; C x Ch – Czech Fleckvieh and Charolais crossbreed; LSM – Least Squares Means; SE – Standard Error

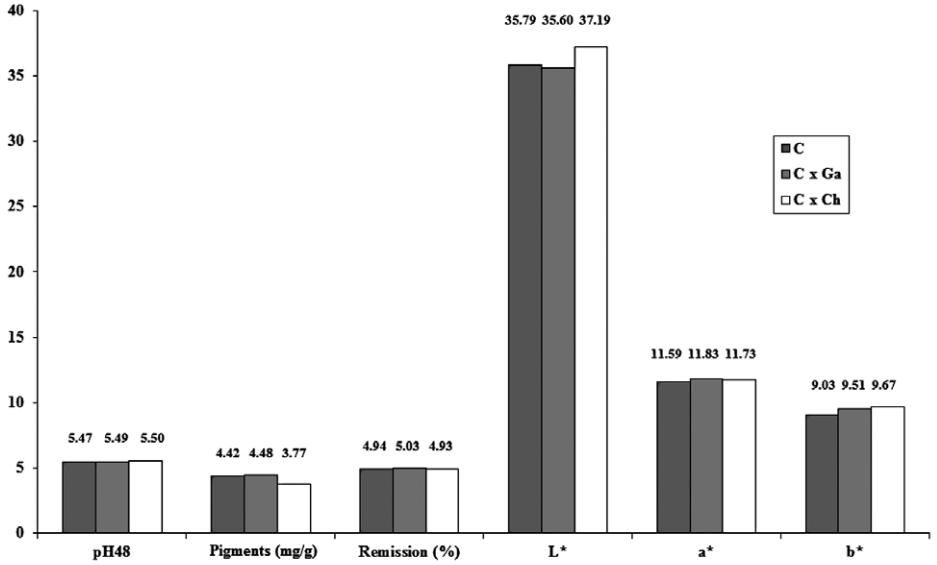

Fig. 2. The pH value and indicators of muscle colour by commercial type of steers
(C – Czech Fleckvieh breed; C x Ga – Czech Fleckvieh and Galloway crossbreed; C x Ch – Czech Fleckvieh and Charolais crossbreed)

Spectral remission measurement identified the group of Ga crossbreeds as the group with the lightest meat (5.03 ± 1.32%), the difference with the Ch crossbreed steers (4.93 ± 0.90%) being significant ($p < 0.05$). The measured values of the colour lightness parameter L* are in agreement with muscle pigment volumes, i.e. the lightest-coloured meat is from Ch crossbreeds. Significant differences ($p < 0.05$) were demonstrated between the C × Ch group (L* 37.19) and the C × Ga group (L* 35.60), as well as the dual-purpose group (L* 35.79). The proportions of the red (a*) and yellow (b*) parts of the spectrum in the groups monitored were very similar; the average values of the red and yellow parts of the spectrum were 11.71 and 9.39, respectively. In their study assessing the colour of the meat of Simmental steers, Čubić et al. (2011) found significantly higher values of lightness (L* 42.85 – 43.34) and the proportion of the red part of the spectrum (a* 23.62 – 23.96), though only slightly lower values of the proportion of the yellow part of the spectrum (b* 8.95 – 9.22).

Conclusions

The results indicate that crossbred Galloway steers attain a slower growth rate than the other groups studied. Dual-purpose steers (C) achieved similar results as their crossbreeds with Charolais beef cattle. From the viewpoint of a healthy diet, our results showed that the nutritional quality of beef meat was highly similar in the groups of steers studied (dry matter, protein and ash). The meat of the C x Ga crossbreeds, however, contained least intramuscular fat (2.11%). The results of a comprehensive assessment of changes in the colour parameters L*, a* and b* in individual groups indicate that the meat of Charolais crossbred steers received the most favourable assessment.

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