The effect of crossbreed on carcass and beef quality

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Abstract

The intent of this study was to evaluate the effect of a commercial type of cattle on the parameters of quality in the beef carcass and its meat (dry matter, content of protein, fat and ash). The values in the CIELab system were also monitored. In total, 87 bulls were involved in the experiment (35 Czech Fleckvieh purebreds (C), 25 C and Galloway (Ga) crossbreds, and 27 C and Charolaise (Ch) crossbreds). Selected parameters were evaluated with regard to the breed of bulls. After the evaluation, the final parameters of beef carcasses indicate that it is better for breeders to raise the Czech Fleckvieh purebreds or crossbreed them with the Charolaise stock. The nutritional parameters of beef were not significantly different between the monitored groups of bulls. Statistically significant differences ($p < 0.05$) were detected in the colour of beef between all groups of bulls. The beef from the C x Ch crossbreed was the palest.

Bulls, CIELab system, pH, remission, intramuscular fat

Introduction

Beef production constitutes an essential part of Czech agriculture. The dominant position of livestock lies primarily in the fact that it is the world's main producer of milk. A significant portion of beef on the domestic market comes from the Czech Fleckvieh cattle, which is not raised only in its pure blooded form since some breeders use it for commercial crossbreeding with other meat-producing types of cattle. The purpose of crossbreeding is to make the animal fattening process more effective while achieving a high growth rate of muscle tissue. The quality of bull carcasses – crossbreds of the Czech Fleckvieh stock with Aberdeen Angus (Aa), Limousine (Li), Meat Simmental (Ms), Blonde d'Aquitaine (Ba), Belgian Blue-White (Bm), and Charolaise (Ch) was compared by Polách et al. (2000). All evaluated carcasses received an almost identical classification in the SEUROP system according to their conformation and degree of fat cover. Sochor et al. (2005) compared 51 bulls – crossbreds of the Czech Fleckvieh stock with those of Charolaise, Meat Simmental, and Blonde d'Aquitaine. Samples of muscle tissue *(musculus longissimus pars dorsi)* were tested for percentages of dry matter, total protein content, intramuscular fat and ash content. The authors did not find these parameters to be significantly different between the various commercial breeds of cattle. However, statistically significant differences ($p < 0.01$) were found in water-holding capacity between the types C x Ch, C x Ba and C x Si, and in the size of MLT area between the crossbreeds Ch x Ba, C x Si and C x Ba. Differences were also found in the amount of collagen ($p < 0.01$) between the types Ch x Ba, Ch x Si, and C x Ba. The colour of meat depends largely on the presence of haem dyes, particularly myoglobin and, to a lesser extent, haemoglobin. The colour is also affected by the degree of marbling and the way the livestock was raised and fed, along with temperature, relative humidity of meat, and illumination (Šubrt 2004). Ruiz de Huidobro et al. (2005) describes the dependence of colour on the concentration of myoglobin and its oxidation level as well as the meat structure. Among other authors who mention colour as an important consumer impression factor are Saláková (2012) and Kameník et al. (2012). Šubrt et al. (2005) published a remission value of 6.29% for the meat from Charolais bulls. The meat coming from Blonde d'Aquitaine bulls was darker, the remission values being 1.19% lower (which represents 5.10%).

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The intent of this study was to evaluate the effect of selected commercial breeds of cattle on the quality parameters of the carcass and the beef it contains.

Materials and Methods

The experiment comprised 87 selected bulls (35 Czech Fleckvieh purebreds - C, 25 crossbreds of C with the Charolaise stock - Ch, and 27 crossbreds of C with the Galloway stock - Ga). The analysis was performed on samples of *longissimus lumborum et thoracis* muscle taken where the carcass was cut in half, at the 9th - 10th thoracic vertebrae level, 48 hours *post mortem.*

These samples of beef were tested for selected nutritional qualitative parameters, namely dry matter content, ash content, protein content by the Kjeldahl method, and intramuscular fat content according to Soxhlet, which were determined per ČSN 57 0185 (1963). The meat was also examined for the following colour indicators: content of muscle pigment by the Hornseye method (1956) and remission measured by Spekol 11 with an attachment at 522 nm wavelength. Also monitored were the parameters defined by the CIELab colour system, specifically lightness (L*), the ratios of the red (a*) and the yellow (b*) spectra as determined by Konica Minolta spectrophotometer CM-2600d. An additional indicator was the pH_{48} value measured by pH meter 340 with a puncture-type electrode. These indicators were tracked in correlation to the commercial breed of bulls.

The statistical evaluation was performed by STATISTICA 10.0. programmes a one-way ANOVA with a fixed effect of the breed category (PL_i). The statistical significance of differences was established by applying the HSD test. The equation used in the calculation was:

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

where
Y_{ij} = resultant corrected value
μ = average value of the dependent variable
PL_i = breed category (Czech Fleckvieh, Galloway, Charolaise)
e_{ij} = residual value

Results and Discussion

The bulls were slaughtered in the weight range of 501 - 663 kg. The net weight increase during the fattening period ranged from 425 to 590 $g.day^{-1}$. The Czech Fleckvieh bulls were slaughtered at the age of 571 days, the age of the (C x Ga) crossbreds was around 668 days ($p < 0.01$), or 624 days ($p < 0.05$) in case of the Ch stock crossbreds. A statistically significant difference in the carcass weight ($p < 0.01$) was found between the groups of

Table 1. Age of bulls at the time of slaughter and their carcass characteristics by the commercial type of bulls

Indicator		C n = 35a	C x G n = 25	C x Ch n = 27	Total n = 87
Age at slaughter (days)	LSM	571 $^{A\,a}$	668 ^{B}	624 ^{b}	615
	SE	69.19	107.61	48.90	86.44
Carcass weight (kg)	LSM	330	281 ^{A}	374 ^{B}	330
	SE	54.02	96.79	64.64	79.59
SEUROP	LSM	4.06 ^{a}	4.56 $^{A\,b}$	3.82 ^{B}	4.13
Comformation (score)*	SE	0.34	0.97	0.62	0.71
SEUROP	LSM	2.10	2.08	2.04	2.07
Fatness (score) **	SE	0.28	0.40	0.34	0.33

Statistical significance between the evaluated groups of bulls: A, B = $p < 0.01$; a, b = $p < 0.05$

* Conformation: S = 1 to P = 6 points

** Degree of fat cover: 1 = 1 up to 5 = 5 points

C – Czech Fleckvieh breed, C x Ch – crossbreed of Czech Fleckvieh and Charolaise stock, C x Ga – crossbreed of Czech Fleckvieh and Galloway stock; LSM – Least Squares Means; SE – Standard Error

crossbreds C x Ga (281 ± 96.79 kg) and C x Ch (374 ± 64.64 kg). A significant difference ($p < 0.01$) was also noted in the conformation category between the commercial types C x Ga and C x Ch, and between the carcasses of the Czech Fleckvieh bulls and the C x Ch crossbreds ($p < 0.05$). An assessment of the degree of fat coverage ($p > 0.05$) did not find a statistically significant difference between any of the studied groups (Table 1).

The selected nutritional value indicators in the bull produced beef are listed in Table 2 and displayed in Fig. 1. The dry matter content among the selected groups varied in the range of 23.81% to 24.25%. The proportion of ash within the groups was very tight (1.10 ± 0.05%). The proportion of protein ranged from 20.98% to 21.36%. The intramuscular fat content exhibited the following levels: group 1 (C) 0.94 ± 0.28%, group 2 (C x Ga) 1.06 ± 0.86% and group 3 (C x Ch) 1.32 ± 1.17%. Filipčík et al. (2008) reported that the content of intramuscular fat in the Czech Fleckvieh bulls was 2.14 ± 1.32%, whereas Bureš and Bartoň (2012) determined the content to be 1.69%. No statistical difference ($p > 0.05$) between the groups of bulls was found for any of the selected indicators, i.e. dry matter content, ash, protein, and intramuscular fat.

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

Indicator		C n = 35a	C x G n = 25	C x Ch n = 27	Total n = 87
Dry matter (%)	LSM	24.25	23.81	24.04	24.06
	SE	0.98	1.30	1.25	1.17
Ash (%)	LSM	1.10	1.11	1.10	1.10
	SE	0.05	0.05	0.04	0.05
Proteins (%)	LSM	21.36	20.98	21.04	21.15
	SE	0.93	0.66	0.87	0.85
Intramuscular fat (%)	LSM	0.94	1.06	1.32	1.09
	SE	0.28	0.86	1.17	0.80

C – Czech Fleckvieh, C x Ch – crossbreed of Czech Fleckvieh and Charolaise stock, C x Ga – crossbreed of Czech Fleckvieh and Galloway stock; LSM – Least Squares Means; SE – Standard Error

The resultant values of pH_{48} and the muscle colour indicators by the commercial type of bulls are presented in Tab. 3 and displayed in Fig.2. Significant differences were found to exist in pH_{48} values at 95% level between the bulls of the Czech Fleckvieh stock and the C x Ga, as well as C x Ch, crossbreeds. The content of muscle pigments did not show any statistically significant differences. A significant difference ($p < 0.05$) was detected in the remission parameter between group C x Ga (5.08 ± 1.37%), group C (4.28 ± 1.34%) and group C x Ch (4.87 ± 1.28%). The meat from Czech Fleckvieh bulls, according to Filipčík et al. (2009), has the remission value of 0.68 ± 3.36%, whereas Voříšková and Frelich (2006) found that value to be 6.30 %. The lightness parameter L* was significantly different ($p < 0.05$) between all groups. The red spectrum ratio (a*) was significantly different ($p < 0.01$) in group C (13.37 ± 10.36) vs. group C x Ga (10.84 ± 2.14), and in group C vs. group C x Ch ($p < 0.05$). While the yellow spectrum ratio (b*) exhibited a highly significant difference ($p < 0.01$) between the group of C bulls (7.76 ± 1.83) and the C x Ch crossbreed (9.45 ± 2.28), the difference between group C and group C x Ga was significant only at the 95% level.

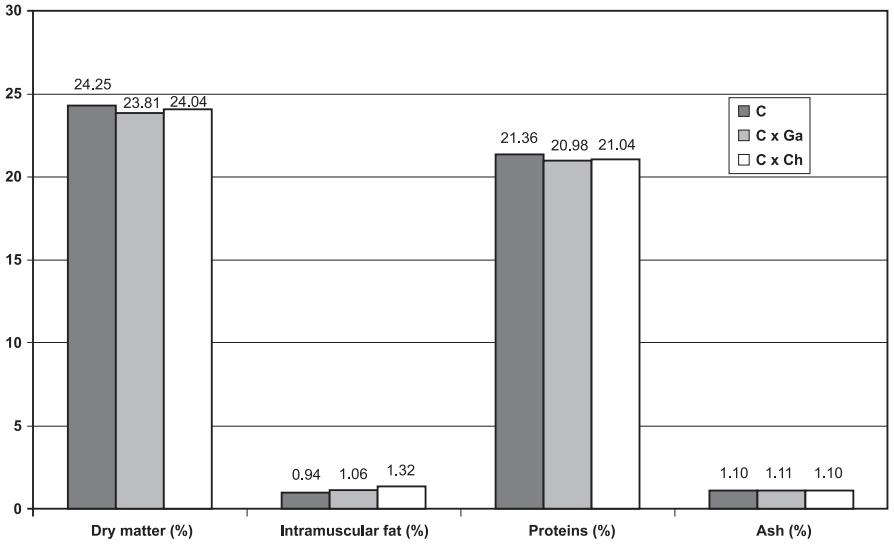

Fig. 1. Indicators of nutritional value of meat by the commercial type of bulls
C – Czech Fleckvieh breed, C x Ch – crossbreed of Czech Fleckvieh and Charolaise stock, C x Ga – crossbreed of Czech Fleckvieh breed and Galloway stock

Table 3. pH value and indicators of muscle colour by the commercial type of bulls

Indicator		C n = 35	C x G n = 25	C x Ch n = 27	Total n = 87
pH48	LSM	5.77^{a}	5.57^{b}	5.56^{b}	5.65
	SE	0.42	0.11	0.13	0.30
Pigments (mg.g^{-1})	LSM	3.64	3.80	3.58	3.67
	SE	0.77	0.81	0.59	0.73
Remission (%)	LSM	4.28^{a}	5.08^{b}	4.87^{a}	4.69
	SE	1.34	1.38	1.28	1.36
L*	LSM	34.48^{a}	35.92^{b}	36.22^{c}	35.43
	SE	3.52	2.60	3.14	3.23
a*	LSM	13.37^{Aa}	10.84^{B}	11.03^{b}	11.92
	SE	10.36	2.14	2.53	6.86
b*	LSM	7.76^{Aa}	8.85^{b}	9.45^{B}	8.60
	SE	1.83	1.18	2.28	1.95

Statistical significance between the evaluated groups of bulls: A, B, C = $p < 0.01$; a, b, c = $p < 0.05$
C – Czech Fleckvieh breed, C x Ch – crossbreed of Czech Fleckvieh and Charolaise stock, C x Ga – crossbreed of Czech Fleckvieh and Galloway stock; LSM – Least Squares Means; SE – Standard Error

Conclusions

In terms of carcass quality, it is advantageous for breeders to raise the Czech Fleckvieh breed in its pure-blooded form, or possibly in commercial crossbreeding with the Charolaise stock. Based on our results, we do not recommend the C x Ga combination to the breeders,

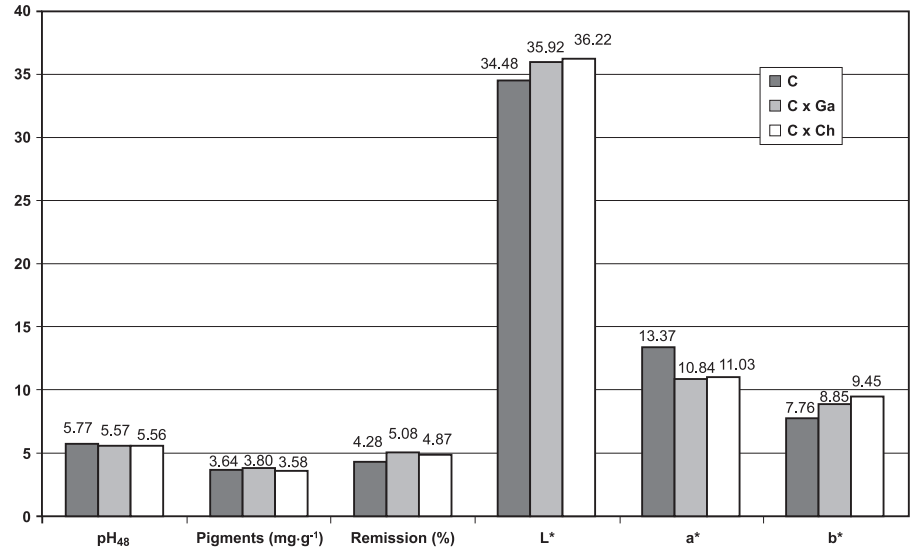

Fig. 2. pH value and indicators of muscle colour by the commercial type of bulls
C – Czech Fleckvieh breed, C x Ch – crossbreed of Czech Fleckvieh and Charolaise stock, C x Ga – crossbreed of Czech Fleckvieh breed and Galloway stock

since that crossbreed does not have the same growth rate and carcass value as the other studied groups of bulls.

From the perspective of a healthy diet, it can be stated that the nutritional quality of beef did not show significant differences between the monitored groups of bulls. The differences were found only in the colour intensity of beef (technological indicator), with the lightest shades of colouration being recorded for the C x Ch crossbreed.

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