The influence of commercial type of heifers on carcass and beef quality parameters

Eliška Dračková, Jan Šubrt, Radek Filipčík

Department of Animal Breeding
Faculty of Agronomy
Mendel University in Brno
Brno, Czech Republic

Abstract

The aim of this study was to determine the influence of the commercial type of heifers on the quality parameters of the carcass and selected qualitative nutritional indicators in beef meat (content of dry matter, intramuscular fat, protein, ash and meat colour parameters). Sixty-six heifers were selected for the experiment – 24 purebred Czech Fleckvieh heifers (C), 22 Czech Fleckvieh x Charolais (Ch) crossbreeds and 20 Czech Fleckvieh x Galloway (Ga) crossbreeds. The monitored indicators were evaluated in dependence on the breed of heifer. From the viewpoint of carcass quality, it is more advantageous for breeders to use a commercial crossbreed with the Charolais breed or to rear Czech Fleckvieh heifers in purebred form. Statistically significant evidence ($P < 0.05$) of differences in indicators of the nutritional quality of beef meat were found only for the content of intramuscular fat between the groups C and C x Ga. A difference was found ($P < 0.05$) in the intensity of colour of beef meat between the group C x Ga and the other groups of heifers. The palest shades were recorded in the meat of C x Ch crossbreeds.

Beef, carcass, heifers, CIELab system

Introduction

A cattle rearing is an inseparable part of Czech agriculture. The dominant position held by cattle lies in the fact that they are the world's primary milk producer. Meat production is, however, also important. A significant proportion of the domestic market is made up of Czech Fleckvieh cattle, which are not merely reared as purebred animals, but also used by many breeders for commercial crossbreeding with specialised meat breeds with the aim of making the fattening of animals for slaughter more effective. A number of authors, such as Oury et al. (2009), Bureš and Bartoň (2012), Drennan and Moloney (2013) and Schiavon et al. (2013) have studied meat yield in heifers. Lage et al. (2012) compared the nutritional composition of the meat of heifers crossbred with the meat breeds Aberdeen Angus and Beef Simmental, in which the content of protein (20.48 and 20.57%), ash (1.32 and 1.12%) and intramuscular fat (2.96 and 2.99%) fell within a narrow range. A sample of the muscle *longissimus* was evaluated 24 hours *post mortem*. The heifers were slaughtered at the age of 18 months; the carcass weight in crossbreeds with Aberdeen Angus was 252 kg, in crossbreeds with Beef Simmental 211 kg. Meat colour depends primarily on the content of haemic pigments, particularly myoglobin, and, to a lesser extent, also haemoglobin. The degree of marbling, the rearing method and the diet of livestock animals all have an influence on colour. Temperature, the relative humidity of the meat and light also influence colour (Šubrt 2004). Moloney et al. (2013), who studied the meat (*m. longissimus thoracis et m. lumborum*, 48 hours *post mortem*) of heifers crossbred with the Charolais breed slaughtered at an average slaughter weight of 443 kg at the age of 18 months, published the following values: lightness L* 35.7, proportion of red colour a* 16.5 and proportion of yellow colour b* 9.6. Hoving-Bolink et al. (1999) found values of L* 35.5, a* 18.0 and b* 14.2 in crossbreeds with the Piemontese breed and values of L* 36.5, a* 18.2 and b* 15.0 in crossbreeds with the Limousine breed in *m. longissimus thoracis* 20 hours after slaughter. The heifers were slaughtered at an average age of 845 days and an average slaughter weight of 525 kg. Heifers meat is extremely tender and juicy

Address for correspondence:
Ing. Eliška Dračková, Ph.D.
Department of Animal Breeding
Faculty of Agronomy
Mendel University in Brno
Zemědělská 1, 613 00 Brno, Czech Republic

Phone: +420 545 133 241
E-mail: drackova@mendelu.cz
www.maso-international.cz

and has a higher intramuscular fat content, while the meat of bulls is drier. The aim of this study was to evaluate the influence of the commercial type of heifers on quality parameters in carcasses and meat.

Materials and Methods

Sixty-six heifers were selected for the experiment, i.e. 24 purebred Czech Fleckvieh heifers (C), 22 Czech Fleckvieh x Charolais (Ch) crossbreeds and 20 Czech Fleckvieh x Galloway (Ga) crossbreeds. Samples of the *m. longissimus lumborum et m. thoracis* taken from the site of the halving cut at the level of the ninth and tenth 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 the Hornsey method (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 pH_{48} 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 heifer.

Statistical evaluation was performed in the program STATISTICA 10.0 using one-way ANOVA with breed as the fixed effect (PL_i). 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_{ij} = resultant corrected value
μ = average value of dependent variable
PL_i = heifer breed (Czech Fleckvieh, Galloway, Charolais)
e_{ij} = residual

Results and Discussion

The heifers were slaughtered at a weight ranging from 408 to 536 kg, with the net weight gain during the fattening period ranging from 341 to 494 $mg \cdot g^{-1}$. The age of the heifers at slaughter ranged from 610 to 672 days (Table 1). A significant difference ($p < 0.05$) was demonstrated between the C x Ch groups of heifers (610 days) and both C heifers

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

Indicator		C n = 24	C x Ga n = 20	C x Ch n = 22	Total n = 66
Age at slaughter [days]	LSM	672[a]	669[a]	610[b]	651
	SE	79.55	78.16	74.83	81.69
Carcass weight [kg]	LSM	291[A]	226[B]	298[A]	274
	SE	60.21	56.32	54.41	64.50
SEUROP	LSM	4.21	4.60	4.09	4.29
Conformation [score] *	SE	0.59	0.94	0.43	0.70
SEUROP	LSM	2.38	2.45	2.59	2.47
Fatness [score] **	SE	0.65	0.61	0.59	0.61

Statistical significance between groups of heifers studied: A, B = $P < 0.01$; a, b = $P < 0.05$
*Conformation: S = 1 to P = 6 points, **Fatness: 1 = 1 to 5 = 5 points
C – Czech Fleckvieh, C x Ch – Czech Fleckvieh x Charolais crossbreed, C x Ga – Czech Fleckvieh x Galloway crossbreed; LSM – Least Squares Means; SE – Standard Error

(672 days) and C x Ga heifers (669 days). The lowest carcass weight was found in C x Ga heifers (226 kg). The greatest carcass weight was seen in crossbreeds with Ch (298 kg), attained, moreover, in a shorter fattening period. The weight of C heifer carcasses was 291 kg. A highly significant difference ($p < 0.01$) in carcass weight was found between C x Ga heifers and both C x Ch and C heifers. The difference between the highest and lowest weight was 72 kg. No significant differences ($p > 0.05$) were found between the groups in terms of evaluation of the conformation and fat cover of the carcasses. All the groups of heifers were classified from 4.09 to 4.60 points for conformation (class R – O) and from 2.38 to 2.59 points for fatness (class 2 – 3). Studený et al. (2012) state a conformation value of 4.00 points (class R) and a fat cover value of 2.89 points (class 3) for C heifers of a carcass weight of 274.7 kg.

Selected nutritional indicators of the quality of heifers meat are given in Table 2. The average dry matter content found in the heifers was 26.51 ± 2.09%. Heifers in the dual-purpose group showed a slightly higher protein content than the other groups (21.16 ± 0.64%). Statistically significant differences were not demonstrated between the groups of heifers for the given nutritional indicators, i.e. the content of dry matter, ash and protein. However, a significant difference ($P < 0.05$) in the content of intramuscular fat was found between the group of Czech Fleckvieh heifers (4.16 ± 2.54%) and the group of crossbreeds with the Galloway meat breed (3.29 ± 2.79%). The intramuscular fat content in the muscle tissue in the group C x Ch was 3.81 ± 1.87%, and this value is only 0.21% higher than that given by Augustini and Troeger (2001). Ruiz de Huidobro et al. (2003) determined an average intramuscular fat content of 3.85% in heifers sired by bulls of the breeds Limousine, Charolais and Brown Swiss, though Bartoň et al. (2007) state a lower intramuscular fat content in Charolais heifers (2.75%).

Table 2. Indicators of a nutritional value of meat by commercial type of heifers

Indicator [%]		C n = 24	C x Ga n = 20	C x Ch n = 22	Total n = 66
Dry matter	LSM	26.87	25.86	26.71	26.51
	SE	2.14	2.39	1.64	2.09
Ash	LSM	1.07	1.07	1.07	1.07
	SE	0.05	0.03	0.04	0.04
Proteins	LSM	21.16	20.98	20.97	21.04
	SE	0.64	0.88	1.06	0.86
Intramuscular fat	LSM	4.16^{a}	3.29^{b}	3.81	3.78
	SE	2.54	2.79	1.87	2.41

Statistical significance between groups of heifers studied: A, B = $P < 0.01$; a, b = $P < 0.05$
C – Czech Fleckvieh, C x Ch – Czech Fleckvieh x Charolais crossbreed, C x Ga – Czech Fleckvieh x Galloway crossbreed; LSM – Least Squares Means; SE – Standard Error

We did not demonstrate any influence of commercial type of heifers on pH_{48} (Table 3). The average pH_{48} value was 5.51 ± 0.10. Least muscle pigment was found in C x Ch heifers (3.51 ± 0.75 mg·g^{-1}), while a significant difference ($P < 0.05$) was found between C x Ch heifers and heifers in both the C x Ga group (3.90 ± 0.71 mg·g^{-1}) and C group (3.85 ± 0.59 mg·g^{-1}). Remission was used as a comparative method. The remission values were not influenced by commercial type, although the value of remission was higher in C x Ch crossbreeds (5.76 ± 1.41%) than in C x Ga heifers (5.38 ± 2.14%) and C heifers

(5.30 ± 1.23%). Dračková et al. (2010) published a value of remission of 5.47% and a muscle pigment content of 3.94 mg·g^{-1} in Czech Fleckvieh heifers. A lower value was recorded for meat lightness L* in C x Ga crossbreeds (36.08 ± 3.36), and a significant difference ($P < 0.05$) was found between C x Ga heifers and C x Ch crossbreeds (37.91 ± 2.56) and heifers of the dual-purpose type (37.23 ± 2.64). The proportion of the red spectrum a* was very similar in all the groups of heifers, with the average value of redness in the meat being 11.23 ± 1.73. Commercial type did not influence the proportion of redness a* in the meat of the heifers. The proportion of yellowness b* fell within a range from 8.97 ± 1.51 to 9.92 ± 1.34, with a lower proportion of yellowness being found in the heifers crossbred with the Galloway breed. No significant difference was, however, demonstrated between the groups. Ruiz de Huidobro et al. (2003) state values of L* 37.61, a* 17.09, b* 5.63, C* 18.00 and h 18.88 in heifers sired by bulls of a commercial meat breed. Page et al. (2001) found meat lightness L* 39.2, redness a* 24.8 and yellowness b* 10.8 in heifers of a carcass weight of 319 kg.

Table 3. Value of pH and indicators of muscle colour by commercial type of heifers

Indicator		C n = 24	C x Ga n = 20	C x Ch n = 22	Total n = 66
pH_{48}	LSM	5.52	5.54	5.48	5.51
	SE	0.07	0.14	0.069	0.10
Pigments [mg·g^{-1}]	LSM	3.85^{a}	3.90^{a}	3.51^{b}	3.75
	SE	0.59	0.71	0.75	0.69
Remission [%]	LSM	5.30	5.38	5.76	5.48
	SE	1.23	2.14	1.41	1.60
L*	LSM	37.23^{b}	36.08^{a}	37.91^{b}	37.11
	SE	2.64	3.36	2.56	2.91
a*	LSM	11.35	11.24	11.10	11.23
	SE	2.30	1.24	1.46	1.74
b*	LSM	9.75	8.98	9.93	9.58
	SE	2.00	1.51	1.34	1.68

Statistical significance between groups of heifers studied: A, B = $P < 0.01$; a, b = $P < 0.05$
C – Czech Fleckvieh, C x Ch – Czech Fleckvieh x Charolais crossbreed, C x Ga – Czech Fleckvieh x Galloway crossbreed; LSM – Least Squares Means; SE – Standard Error

Conclusions

Using a commercial crossbreed with the Charolais breed or rearing Czech Fleckvieh heifers as purebred animals is more appropriate for breeders from the viewpoint of carcass quality. Good growth intensity in the shortest time period was found in C x Ch crossbreeds. On the basis of our results, we do not recommend that breeders use the C x Ga combination for intensive production as these crossbreeds do not attain such high growth intensity or carcass value as the other groups of heifers monitored in our study.

From the viewpoint of a healthy nutrition, our results showed that the nutritional quality of beef meat was highly similar in the groups of heifers studied. The meat of the C x Ga crossbreed contained least intramuscular fat (3.29%). The results of a comprehensive assessment of group changes in the colour parameters *L, a*, b* indicate that the meat of hybrid heifers crossbred with the Charolais breed received the most favourable assessment.

Acknowledgements

This study was supported by the project NAZV QI91A055.

References

Augustini C, Troeger K 2001: Qualitätsorientierte Rindfleischerzeugung – Fleischqualität aus einer Spezialproduktion. Fleischwirtschaft **81**: 1075-1078 (In German)

Bartoň L, Marounek M, Kudrna V, Bureš D, Zahrádková R 2007: Growth performance and fatty acid profiles of intramuscular and subcutaneous fat from Limousin and Charolais heifers fed extruded linseed. Meat Sci **76**: 517-523

Bureš D, Bartoň L 2012: Growth performance, carcass trans and meat of bulls and heifers slaughtered at different ages. Czech J Anim Sci **57**: 34-43

ČSN 57 0185 1963: Czech National Standard. Zkoušení masa, masných výrobků a masných konzerv, Praha, 1-20 (In Czech)

Dračková E, Šubrt J, Filipčík R 2010: Vliv pohlaví českého strakatého skotu na vývoj parametrů barvy. In Sborník příspěvků z mezinárodní vědecké konference a semináře pro chovatele Šlechtění na masnou užitkovost a aktuální otázky produkce jatečných zvířat. Brno: MENDELU, 133-136 (In Czech)

Hoving-Bolink AH, Hanekamp WJA, Walstra P 1999: Effects of sire breed and husbandry system on carcass, meat and eating quality of Piemontese and Limousin crossbred bulls and heifers. Livest Prod Sci **57**: 273-278

Lage JF, Paulino PVR, Valadares Filho SC, Souza EJO, Duarte MS, Benedeti PDB, Souza NKP, Cox RB 2012: Influence of genetic type and level of concentrate in the finishing diet on carcass and meat quality traits in beef heifers. Meat Sci **90**: 770-774

Moloney AP, Mooney MT, Kerry JP, Stanton C, O'Kiely P 2013: Colour of fat, and colour, fatty acid composition and sensory characteristics of muscle from heifers offered alternative forages to grass silage in a finishing kation. Meat Sci **95**: 608-615

Moloney AP, Drennan MJ 2013: Characteristics of fat and muscle from beef heifers offered a grass silage or concentrate-based finishing ration. Livest Sci **152**: 147-153

Oury MP, Picard B, Briand M, Blanquet JP, Dumont R 2009: Interrelationships between meat quality traits, texture measurements and physicochemical characteristics of M. rectus abdominis from Charolais heifers. Meat Sci **83**: 293-301

Page JK, Wulf DM, Schwotzer TR 2001: A survey of beef muscle color and pH_1. J Anim Sci 79: 678-687

Ruiz de Huidobro F, Miguel E, Onega E, Blázquez B 2003: Changes in meat quality characteristics of bovine meat during the first 6 days post mortem. Meat Sci **65**: 1439-1446

Schiavon S, Tagliapietra F, Cesaro G, Gallo L, Cecchinato A, Bittante G 2013: Low crude protein diets and phase feeding for double-muscled crossbred young bulls and heifers. Livest Sci **157**: 462-470

Studený S, Falta D, Komzáková I, Chládek G 2012: Vliv věku při porážce na vybrané ukazatele masné užitkovosti jalovic českého strakatého plemene skotu. In Sborník příspěvků z mezinárodní vědecké konference a semináře pro chovatele Šlechtění na masnou užitkovost a aktuální otázky produkce jatečných zvířat. Brno: MENDELU, p. 103-106 (In Czech)

Šubrt J 2004: Kvalita hovězího masa. In Sborník příspěvků k semináři „Genetické základy šlechtění na kvalitu jatečných těl a hovězího masa s možností využití výkrmu volků". Rapotín, VUCHS Rapotín, 65-81 (In Czech)