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THE EFFECT OF GENOTYPE (PUREBRED CZECH FLECKVIEH AND THEIR CROSSES) ON SOME BEEF QUALITY CHARACTERISTICS IN BULLS

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Abstract

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The aim of this study was to determine the effect of genotype of bulls (the proportion of Czech Fleckvieh cattle in milk-producing cattle population in the Czech Republic) on carcass quality traits and some nutritional and processing quality characteristics of beef (dry matter content, intramuscular fat content, protein content, ash content, water holding capacity, muscle fibre diameter, and meat colour characteristics). The experiment included 419 bulls of Czech Fleckvieh breed (C), out of which 165 were pure-bred (C_{100}), 163 crossbred of $C_{76–88}$ genotype and 91 crossbred of $C_{50–75}$ genotype. The association between meat quality traits and genotype of bulls was assessed.
Purebred bulls C_{100} or crosses with a greater proportion of Czech Fleckvieh $C_{76–88}$ showed more favourable dressed-carcass quality. One of the nutritional quality traits of beef – protein content – differed significantly ($p < 0.05$) in groups C_{100} and $C_{76–88}$. MLLT area and muscle fibre diameter were significantly different ($p < 0.01$) in $C_{50–75}$ bulls who also had the darkest ($p < 0.01$) colour of meat.

Keywords: Czech Fleckvieh, bulls, beef quality, beef colour

INTRODUCTION

Worldwide, dairy cattle is a major milk producer and also an important producer of beef. In the Czech Republic, the dairy cattle population includes mainly Holstein cattle and then dual-purpose Czech Fleckvieh cattle. Czech Fleckvieh cows are important milk producers and when crossbred to typical beef cattle breeds, their offspring are efficient producers of high-quality beef.

Bartoň *et al.* (2010) studied beef quality of Czech Fleckvieh cattle and their crosses with beef breeds. Beef of Czech Fleckvieh x Charolais crosses was of a lighter colour (L* 41.0) and contained less intramuscular fat (1.28%) than C bulls (L* 36.6, 1.40%). Šubrt *et al.* (2008) looked into differences in muscle tissue quality of Czech Fleckvieh and Montbeliarde bulls. Their analyses did not prove any significant interbreed differences ($p > 0.05$) in processing and nutritional characteristics of beef. Zapletal *et al.* (2009) also studied differences in chemical properties of beef of Czech Fleckvieh and Montbeliarde bulls and found no significant differences ($p > 0.05$) in nutritional quality of beef. Dawson *et al.* (2010) examined beef colour characteristics in fattened Holstein bulls. Bulls in the control group were slaughtered at 538 kg of live weight and lightness of beef colour was L* 37.7. Minchin *et al.* (2009) and Lee *et al.* (2009) focused on quality of beef of Holstein dairy cattle.

The aim of this study was to assess the effect of genotype (purebred Czech Fleckvieh and crosses) on meat quality.

MATERIAL AND METHODS

The experiment included 419 bulls out of which 165 bulls were purebred Czech Fleckvieh cattle (C_{100}). The rest of the experimental animals were crosses of Czech Fleckvieh and most of all Holstein breed and marginally Ayrshire breed (the maximum proportion of Ayrshire breed was less than 3.125%). The crosses were assigned into two groups – bulls

(n = 163) with proportion of Czech Fleckvieh between 76–88% ($C_{76–88}$) and bulls (n = 91) with proportion of Czech Fleckvieh between 50–75% ($C_{50–75}$).

Fattened bulls were group-housed in a barn. The feed ration (FR) consisted of maize silage – 60% FR (78 g crude protein (CP), 6.18 MJ netto energy (NE)), clover-grass silage – 10% FR (150.6 g CP, 5.6 MJ NE), meadow hay 10% FR (102 g CP, 5.1 MJ NE) and concentrate mixture S-1 – 20% FR. The fattened bulls were slaughtered at a commercial abattoir and dressed carcasses chilled in a cold store for 24 hours (temperature ±2 °C). Then the carcasses were dissected and a sample of muscle (*musculus longissimus lumborum et thoracis* – MLLT) taken up from the cut between 9th and 11th chest vertebra. Laboratory analyses were carried out in the biotechnological laboratory of Mendel University in Brno. The meat was analysed for nutritional characteristics – dry matter content, ash, protein content (by Kjeldahl method) and intramuscular fat content (Soxhlet method, ČSN 57 0185, 1963). Then the following beef processing characteristics were determined: water holding capacity by a modified method of Grau and Hamm (1952), pH_{48} value was measured by pH–meter 340/SET-1 with puncture electrode (WTW, Germany), MLLT cross-sectional area was measured by planimeter and muscle fibre diameter assessed by microscopic device and Leica software (Němcová *et al.*, 2010). The samples were also tested for the following beef colour characteristics: content of muscle pigments was detected by Hornsey method (1956), remission was determined by Spekol 11 with handgrip (Carl Zeiss Jena, Germany) at a wavelength of 522 nm. Other parameters were assessed using colour CIELab – lightness (L*), redness (a*) and yellowness (b*). The analyses were carried out by spectrophotometer Konica Minolta CM - 2600d (Konica Minolta, Japan). To ensure standard conditions, the measuring slit was set at 8 mm, light source "day light" – D65, 10° standard observation angle and SCI mode. The observed characteristics were evaluated with respect to the genotype of the bulls.

The data were statistically analysed by one-way analysis ANOVA with the fixed effect of breed (PL_i) using STATISTICA 10.0. (StatSoft, Inc., Tulsa, Oklahoma, USA). The statistical significance of differences was determined by HSD test. Equation of calculation:

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

where
Y_{ij} ..... corrected result value,
μ ..... mean value of dependant variable,
PL_i .... Czech Fleckvieh breed proportion (C_{100}, $C_{76–88}$, $C_{50–75}$),
e_{ij} ..... residuum.

RESULTS AND DISCUSSION

Bulls in group $C_{50–75}$ were slaughtered at the age of 585 days, in group C_{100} at 568 days and in group $C_{76–88}$ at 565 days on average (Tab. I). The slaughter weight ranged between 597 ± 35.10 kg. The live weight was the highest in C_{100} bulls (601 ± 50.76 kg). The live weight of $C_{76–88}$ bulls was by 10 kg lower (591 ± 32.37 kg). Bartoň *et al.* (2007) slaughtered their experimental Czech Fleckvieh bulls at a similar live weight (602.5 kg) at the age of 536 days. On the contrary, Bezdíček *et al.* (2010) reported a lower slaughter weight (583 kg) in Czech Fleckvieh bulls slaughtered at the age of 557 days. The carcass weight varied between 329 ($C_{50–75}$) and 337 kg (C_{100}). The net weight gain during the fattening ranged from 562 g.day^{-1} ($C_{50–75}$) to 605 g.day^{-1} (C_{100}) but the inter-group differences were not statistically significant ($p > 0.05$). Zapletal *et al.* (2009) determined the net weight gain 630 g.day^{-1} in Czech Fleckvieh bulls with the live weight of 665.8 kg and in Montbeliarde bulls (live weight 706.7 kg) the net weight gain was

I: *Beef performance characteristics of bulls*

Characteristic		C_{100} n = 165	$C_{76–88}$ n = 163	$C_{50–75}$ n = 91	Total n = 419
Age at slaughter (day)	LSM	568	565	585	571
	SE	19.82	11.40	15.49	17.63
Final live weight (kg)	LSM	601	591	593	597
	SE	50.76	32.37	46.54	35.10
Carcass weight (kg)	LSM	337	331	329	333
	SE	34.87	36.15	59.41	48.12
Average daily gain (g.day^{-1})	LSM	605	586	562	582
	SE	89.90	64.12	76.46	80.11
SEUROP Conformation (score) /*	LSM	4.09	4.17	4.13	4.13
	SE	0.33	0.41	0.40	0.38
SEUROP Fatness (score) /**	LSM	2.25	2.20	2.23	2.23
	SE	0.49	0.46	0.45	0.47

*Conformation: S = 1 to P = 6 points, **Fatness: 1 = 1 to 5 = 5 points
C – Czech Fleckvieh, LSM – Least Squares Means, SE – Standard Error

681 g.day^{-1}. The most common conformation class was „R" and external fatness class „2". Corrazin *et al.* (2012) and Dawson *et al.* (2010) published similar results of conformation and fatness classification of carcass of Holstein and Simental bulls in SEUROP.

The nutritional quality of beef (Tab. II) was characterised by the dry matter content 25.72 ± 1.52%. The ash content was similar in all groups 1.08 ± 0.04%. Bulls in group C_{100} had the lower ($p < 0.05$) protein content in beef (21.23 ± 0.84%) and group $C_{76–88}$ the highest (21.51 ± 0.79%), the difference was highly significant ($p < 0.01$). The intramuscular fat content grew linearly with the decreasing proportion of Czech Fleckvieh in genotype of bulls but the differences were not significant ($p > 0.05$; C_{100} = 2.26%; $C_{76–88}$ = 2.29%; $C_{50–75}$ = 2.40%). These nutritional quality values of meat of Czech Fleckvieh bulls correspond with findings of several authors e.g. Zapletal *et al.* (2009) determined the dry matter content 25.00%, ash content 1.06%, protein content 21.60% and intramuscular fat content 2.05%. Šubrt *et al.* (2008) found out dry matter content 25.13%, ash content 1.08%, protein content 21.70% and intramuscular fat content 2.10%. Nutritional quality characteristics of meat of Czech Fleckvieh bulls presented by Bartoň *et al.* (2010) were somewhat different: the dry matter content 24.47%, protein content 21.18% and intramuscular fat content 1.40%.

Processing quality characteristics of beef are presented in Tab. III. The average water holding capacity was 82.54 ± 5.68%, pH_{48} ranged between 5.61 to 5.71. The genotype of the experimental bulls had no effect of values of water holding capacity or pH_{48}. Bulls $C_{76–88}$ had the smallest cross-sectional area of MLLT (86.33 ± 13.76 cm^2), while $C_{50–75}$ the greatest (97.04 ± 17.65 cm^2). Šubrt *et al.* (2008) determined the MLLT area in Montbeliarde bulls slaughtered at the age of 564 days to be 93.21 cm^2. In our experiment the MLLT area was 88.47 ± 15.35 cm^2 in group C_{100}. The difference in the MLLT area was highly significant ($p < 0.01$) between $C_{50–75}$ and C_{100} bulls and between $C_{50–75}$ and $C_{76–88}$ bulls. There was also a significant difference ($p < 0.01$) in the muscle fibre diameter between $C_{50–75}$ bulls (39.08 ± 3.57 µm) and C_{100} bulls (37.36 ± 3.69 µm). Filipčík *et al.* (2015) determined a smaller muscle fibre diameter (by almost 2 µm–35.61 µm) in Czech Fleckvieh bulls (C_{100}). The average muscle fibre diameter in $C_{76–88}$ bulls was 38.05 ± 3.97 µm. Němcová *et al.* (2010) found out similar values of the muscle fibre diameter (38.63 ± 3.11 µm).

Tab. IV presents muscle colour characteristics in the observed breed groups. Beef of $C_{50–75}$ bulls contained more muscle pigments (4.15 mg.g^{-1}), which was by 0.49 mg.g^{-1} more than in meat of C_{100} bulls. The difference in pigment content was significant ($p < 0.01$) between group $C_{50–75}$ and

II: *Nutritional quality of beef*

Characteristic		C_{100} n = 165	$C_{76–88}$ n = 163	$C_{50–75}$ n = 91	Total n = 419
Dry matter (%)	LSM	25.56	25.77	25.95	25.72
	SE	1.53	1.47	1.57	1.52
Ash (%)	LSM	1.08	1.08	1.08	1.08
	SE	0.04	0.04	0.04	0.04
Total protein (%)	LSM	21.23 ^{a}	21.51 ^{b}	21.36	21.37
	SE	0.84	0.79	0.78	0.82
Intramuscular fat (%)	LSM	2.26	2.29	2.40	2.30
	SE	1.34	1.33	1.44	1.36

Statistical significance of differences between the experimental groups: A, B = $p < 0.01$; a, b = $p < 0.05$
C – Czech Fleckvieh, LSM – Least Squares Means, SE – Standard Error

III: *Processing quality of beef*

Characteristic		C_{100} n = 165	$C_{76–88}$ n = 163	$C_{50–75}$ n = 91	Total n = 419
Water holding capacity (%)	LSM	82.20	83.13	82.09	82.54
	SE	5.72	5.60	5.71	5.68
pH_{48}	LSM	5.71	5.67	5.61	5.67
	SE	0.35	0.34	0.29	0.33
MLLT area (cm^2)	LSM	88.47 ^{A}	86.33 ^{A}	97.04 ^{B}	89.50
	SE	15.35	13.76	17.65	15.80
Average diameter of muscle fibres (µm)	LSM	37.36 ^{A}	38.05	39.08 ^{B}	38.00
	SE	3.69	3.97	3.57	3.82

Statistical significance of differences between the experimental groups: A, B = $p < 0.01$; a, b = $p < 0.05$
C – Czech Fleckvieh, LSM – Least Squares Means, SE – Standard Error

IV: *Beef colour characteristics*

Characteristic		C_{100} n = 165	$C_{76–88}$ n = 163	$C_{50–75}$ n = 91	Total n = 419
Pigments (mg.g^{-1})	LSM	3.66 ^{A}	3.70 ^{A}	4.15 ^{B}	3.78
	SE	0.65	0.83	0.82	0.79
Remission (%)	LSM	4.45	4.62 ^{a}	4.04 ^{b}	4.43
	SE	1.53	1.62	1.47	1.56
L*	LSM	35.48	35.86	34.79	35.48
	SE	3.63	3.76	3.30	3.63
a*	LSM	14.16	16.35	15.20	15.24
	SE	9.68	11.52	9.40	10.40
b*	LSM	8.56	8.80	8.38	8.62
	SE	1.86	2.22	1.53	1.95

Statistical significance of differences between the experimental groups: A, B = $p < 0.01$; a, b = $p < 0.05$
C – Czech Fleckvieh, LSM – Least Squares Means, SE – Standard Error

groups C_{100} (3.66 mg.g^{-1}) and $C_{76–88}$ (3.70 mg.g^{-1}). Also, remission values confirmed that beef of $C_{50–75}$ bulls is darker (4.04%) compared to C_{100} and $C_{76–88}$ groups with remission of 4.45 and 4.62%, respectively. Remission values differed significantly ($p < 0.05$) in beef of $C_{50–75}$ and $C_{76–88}$ bulls. Lightness parameter L* ranged between 34.79 and 35.86; beef of $C_{50–75}$ bulls tended to be darker. Redness (a*) was lower in C_{100} bulls (a* = 14.91). Beef of $C_{76–88}$ bulls had a* = 16.35 and $C_{50–75}$ bulls a* = 15.20. Yellowness (b*) ranged between 8.38 ($C_{50–75}$) and 8.80 ($C_{76–88}$). The intergroup differences in colour parameters (L*, a*, b*) were not significant ($p > 0.05$). Bartoň *et al.* (2010) determined greater values of lightness and yellowness in meat of Czech Fleckvieh bulls (L* = 36.6, b* = 12.3) and lower values of redness (a* = 13.4) compared to our results. Keane and Allen (1998) found out similar values of beef colour characteristics (L* = 35.8, a* = 17.9, b* = 8.1) in Charolais x Friesian crosses. Węglarze (2010) claimed that beef of crosses with a high proportion of Holstein breed is paler (L* = 37.40) and its redness and yellowness are lower (a* = 13.44, b* = 3.76).

CONCLUSION

SEUROP classification of carcass conformation did not reveal any differences between groups of bulls with different proportion of Czech Fleckvieh genotype, all the experimental animals were classified as „R2“. Other beef performance characteristics were similar in groups C_{100} and $C_{76–88}$.

Nutritional values of beef were similar for all the groups, only the protein content differed significantly ($p < 0.05$) between bulls C_{100} (21.23 ± 0.84%) and $C_{76–88}$ (21.51 ± 0.79%).

Processing characteristics pH_{48} and water holding capacity were not affected by genotype of bulls. $C_{50–75}$ bulls had the highest ($p < 0.01$) MLLT area (97.04 ± 17.65 cm^2) and muscle fibre diameter (39.08 ± 3.57 µm).

Beef colour was significantly ($p < 0.01$) the darkest in $C_{50–75}$ bulls as proved by values of the muscle pigment content (4.15 mg.g^{-1}) and remission (4.04%). The lightness L* was also different (34.79) but the difference was not statistically significant. The results suggested that beef colour was affected by a higher proportion of dairy breeds in genotypes of bulls.

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