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Meat quality characteristics of beef from Charolais and Simmental bulls fed different diets

D. Bureš, L. Bartoň, V. Teslík, R. Zahrádková
Research Institute of Animal Production
Přátelství 815, Prague - Uhříněves, 104 00, the Czech Republic

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Abstract:
The objective of the study was to compare physical, chemical, and sensory characteristics of *m. longissimus thoracis* from 46 Charolais (CH) and Simmental (SI) bulls. Within the breed, the animals were allocated to two dietary treatments and given two isonitrogenous and isocaloric diets based on maize silage, alfalfa hay, straw, and concentrates supplemented with either whole sunflower seed (EXP) or Megalac (CON) as a source of dietary fat. The bulls were slaughtered at the average live weight 640±38 kg and age 546±28 days. The statistic analysis was performed using the general linear model with breed and diet as fixed effects. The colour of meat was significantly lighter ($P<0.001$) and less reddish ($P<0.05$) in CH compared to SI bulls. No breed or diet effects were found for the chemical composition of muscle except for a higher hydroxyproline content in CH ($P<0.001$) than in SI. Sensory evaluation performed by a trained panel using a 7-point scale revealed a higher score ($P<0.001$) for texture in CH than SI while no differences ($P>0.05$) were shown between the dietary treatments. As indicated by triangle tests, the panellist were, however, mostly able to detect differences between breeds and dietary treatments.

Introduction:

Consumers evaluate the acceptance of food products on the basis of a number of characteristics, such as sensory properties, nutritional value or impact on health (Monsón et al., 2005). Particularly flavour, juiciness and tenderness contribute to the consumer's perception of meat palatability or satisfaction derived from consuming beef (Sochor et al., 2005). Beef quality and its sensory characteristics are influenced by a number of factors including breed (Chambaz et al., 2003), diet (Sami et al., 2003), growth intensity, gender, pH value, marbling, ageing of meat etc. (Thompson, 2002).

Gibb et al. (2004) reported that sunflower seed contains over 40 % oil with most of fatty acids unsaturated. Sunflower oil consist of more than 60 % PUFA n-6 and 20 % PUFA n-3 (Valsta et al., 2005). Fatty acids from consumed fats are partially hydrogenated in the rumen. During this process, conjugated linoleic acid (mainly c9,t11 and t10,c12 isomers) is generated. Anticancerogenic, antidiabetic, antiatherogenic, and other effects are attributed to this fatty acid (reviewed by Schmid et al., 2006).

The objective of this study was to evaluate dietary and breed effects on physical, chemical and sensory properties of beef from young bulls.

Material and methods:

A total of 46 purebred Charolais (CH) and Simmental (SI) bulls were used in the experiment. After weaning at approximately 8 months of age they were loose housed and given two isocaloric and isonitrogenous diets. Both mixed diets consisted of maize silage, alfalfa hay, straw, and concentrates. In addition, they were supplemented with either whole sunflower seed (EXP) or Megalac (CON) as a source of dietary fat (5 % on a DM basis). The animals were slaughtered in the target live-weight 640 kg. Samples of *m. longissimus thoracis* (MLT) at the 9th rib were collected 24 hours *post mortem*. Measurements of pH (Orion 250 A) were conducted 24 and 48 h *post mortem*. Furthermore, drip loss and colour of meat (Spectrophotometer Minolta CM-250d, data L*, a* and b*) were determined 24 h *post mortem*. Chemical analysis involved determination of dry matter (drying at 105 °C), protein (Kjeltec AUTO 1030 Analyzer), lipid (Soxtec 1047) and cholesterol contents. Sensory characteristics were evaluated by trained panellists. The joints were stewed for 150 min. The panellists scored odour, flavour, texture and juiciness using a 7-point ordinal scale (1 – worst, 7 – best). Differences between breeds and diets were also evaluated using triangle tests. Each assessor received a set of three samples; two were alike (from the bull of one group), and one was different (from the bull of another group). The assessors had to report which of the three samples was different and, in addition, whether the overall liking of the different sample was higher or lower or there was no differences.

Physical and chemical characteristics were analysed using the linear model with fixed effects of breed and diet and interaction breed x diet. In the linear model used for evaluation of sensory properties, fixed effects of breed, diet, session and panellist and interaction breed x diet were included. The statistic analyses were performed using the GLM procedure of SAS (SAS Institute Inc., 2001). No interactions were detected and therefore only LS means ± SEM for the main effects of breed and diet are shown in tables.

Results and discussion:

Initial weight, slaughter weight, slaughter age and daily live weight gain are given in Table 1. No differences in these traits were found between the groups.

Physical characteristics given in Table 2 show that the pH values measured 24 and 48 hours *post mortem* were similar between breeds and diets. None of the animals had the ultimate pH above 5.8 which is the threshold indicating the incidence of abnormal beef (Egbert and Cornforth, 1986). Sochor et al. (2005) reported higher pH 48 in crossbred bulls after Charolais sires compared to bulls sired by Simmentals. The colour of meat was significantly darker ($P<0.001$) and more reddish ($P<0.05$) in SI than in CH. In agreement with our results, Chambaz et al. (2003) observed a similar tendency in CH and SI steers. The used diets did not significantly affect the physical properties of meat.

The results of chemical composition are shown in Table 3. The samples from SI tended to higher content of dry matter while contents of protein, ash, intramuscular fat and cholesterol were similar in both breeds. A higher content of hydroxyproline was found in CH. Bartoň et al. (1997) did not observed any differences between these breeds in muscle chemical composition while Sochor et al. (2005) reported a higher content of collagen in SI compared to CH. No effect of diet on the chemical composition of meat was revealed.

It is evident from Table 4 that meat from CH received higher scores for odour, flavour and texture while juiciness was almost the same. However, significant differences were found only in texture ($P<0.001$). Similar tendencies were also reported by Bureš et al. (2006) for CH and SI bulls and Chambaz et al. (2003) for steers. No significant effects of diet on sensory attributes were observed. However, there was a consistent tendency towards lower scores in the experimental (sunflower fed) group particularly for odour and juiciness. In agreement with our study, no differences in sensory properties were found in steers fed a diet supplemented with sunflower oil (Mir et al., 2003). Most of sensory characteristics were, however, slightly improved compared to

the control. Gibb et al. (2004) reported that sunflower seed supplementation (14 % DM) increased tenderness and juiciness of meat from steers without any negative effects on flavour. Feeding high-fat diets and subsequently elevated PUFA n-3 contents in animal tissues may negatively influence various meat characteristics due to oxidative deterioration of animal fats (Durand et al., 2005). Campo et al. (2003) reported that various proportions of FA acids (particularly unsaturated) influence odour and flavour of cooked meat.

Triangle tests (Fig. 1 and 2) revealed that the assessors were able to recognize the different sample in 84 and 78 % of breed and diet comparisons, respectively. The comparisons of the overall liking corresponded to the results of the sensory evaluation given in Table 5. CH was better in 50.6 %, SI better in 31.5 %, and no difference was found in 17.9 %. Less evident differences were observed in the diet comparison (CON better in 33.8 , EXP better in 43.6, and no difference in 22.6 %).

Conclusions

Meat from SI bulls was darker and more reddish and contained less hydroxyproline. Sunflower supplementation did not affect physical properties and chemical composition. Meat from CH received a higher score for texture and was preferred in triangle tests. No significant effects of diet on sensory attributes were observed. However, there was a consistent tendency towards lower scores in the experimental group particularly for odour and juiciness. This might be associated with oxidative reactions in meat after slaughter of sunflower fed animals.

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Table 1: Feed efficiency

	Breed		Nutrition		Significance	
	CH (n=22)	**SI** (n=24)	**CON** (n=22)	**EXP** (n=24)	**Breed**	**Nutrition**
Initial weight (kg)	356.54±13.5	357.33±12.8	356.33±13.5	357.54±12.8	0.9663	0.9485
Daily live-weight gain (kg/day)	1.389±0.043	1.340±0.041	1.392±0.043	1.336±0.041	0.4199	0.3598
Age at slaughter (days)	547.18±6.24	546.21±5.95	547.31±6.24	546.08±5.95	0.9105	0.8877
Slaughter weight (kg)	645.17±8.37	635.92±7.98	640.38±8.37	640.71±7.98	0.4281	0.9771

Table 2: Physical properties

	Breed		Nutrition		Significance	
	CH (n=22)	**SI** (n=24)	**CON** (n=22)	**EXP** (n=24)	**Breed**	**Nutrition**
Value pH 24	5.62 ±0.02	5.64±0.02	5.62±0.02	5.64±0.02	0.3699	0.6384
Value pH 48	5.60±0.04	5.60±0.04	5.60±0.04	5.60±0.04	0.9119	0.9853
Drip loss 24 h (%)	2.26±0.15	2.05±0.14	2.03±0.15	2.29±0.14	0.3058	0.2056
Colour L*	46.08±0.61	41.38±0.58	43.85±0.61	43.61±0.58	<0.0001	0.7811
Colour a*	11.59±0.38	12.74±0.36	11.91±0.38	12.42±0.36	0.0351	0.3443
Colour b*	13.33±0.25	12.55±0.24	12.94±0.25	12.93±0.24	0.0283	0.9801

Table 3: Chemical composition

	Breed		Nutrition		Significance	
	CH (n=22)	**SI** (n=24)	**CON** (n=22)	**EXP** (n=24)	**Breed**	**Nutrition**
Dry matter (g/kg)	241.07±0.95	243.50±0.91	242.47±0.95	242.10±0.91	0.0718	0.7773
Protein (g/kg)	201.67±1.33	203.63±1.27	201.94±1.32	203.36±1.27	0.2939	0.4416
Crude ash (g/kg)	9.96±0.08	9.94±0.07	9.93±0.08	9.97±0.07	0.8749	0.7530
Fat (g/kg)	14.80±0.99	14.78±0.95	15.39±0.99	14.18±0.95	0.9899	0.3831
Hydroxyproline (g/kg)	0.691±0.016	0.605±0.016	0.645±0.016	0.650±0.016	0.0004	0.8266
Cholesterol (g/kg)	0.575±0.025	0.576±0.024	0.594±0.024	0.557±0.024	0.9617	0.2943

Table 4: Organoleptic properties

	Breed		Nutrition		Significance	
	CH (n=22)	**SI** (n=24)	**CON** (n=22)	**EXP** (n=24)	**Breed**	**Nutrition**
Odour	5.60±0.08	5.55±0.08	5.63±0.08	5.51±0.08	0.4500	0.0534
Flavour	5.68±0.09	5.55±0.09	5.65±0.09	5.58±0.09	0.0686	0.3278
Texture	5.68±0.10	5.28±0.10	5.54±0.10	5.43±0.10	<0.0001	0.1645
Juiciness	5.25±0.09	5.26±0.09	5.32±0.09	5.19±0.09	0.9319	0.0720

Fig. 1: Triangle test - comparison of CH and SI (%)

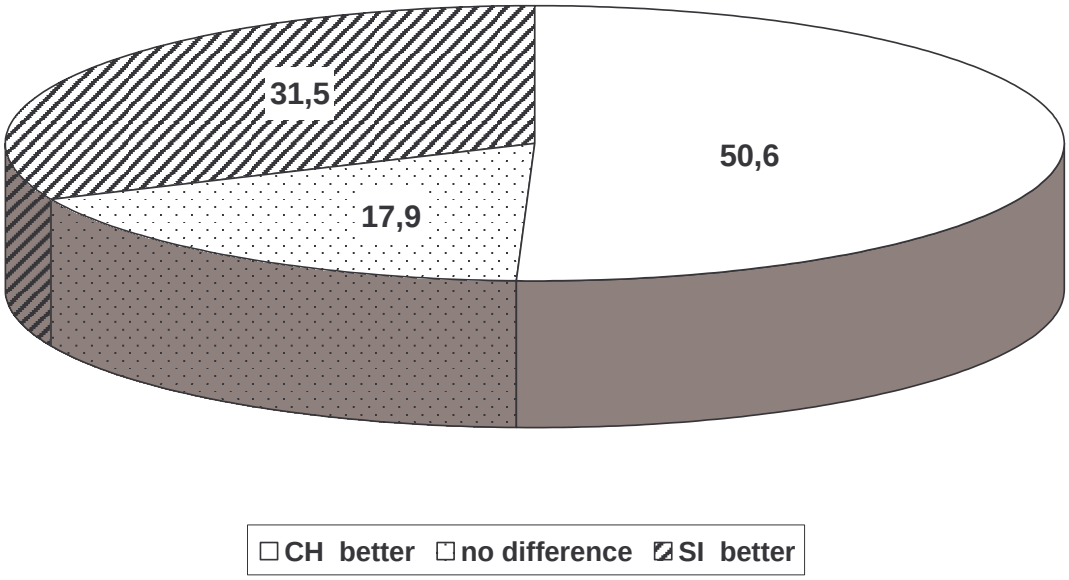

Fig. 2: Triangle tests - comparsion of CON and EXP (%)