The chemical composition and sensory characteristics of meat from Aberdeen Angus, Gascon, Holstein and Czech Fleckvieh bulls

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Abstract

This study aimed to evaluate differences in the chemical composition and sensory characteristics of the meat of bulls of the breeds Aberdeen Angus, Gascon, Holstein and Czech Fleckvieh fattened under identical housing and nutritional conditions. The animals were slaughtered at an average weight of 657 ± 32.7 kg when they reached the age of 17 months. The highest content of intramuscular fat and the lowest value of Warner Bratzler shear force measured in grilled samples of sirloin were found in the meat of Aberdeen Angus bulls. The most favourable evaluation was also recorded in this breed for all the remaining sensory characteristics with the exception of beef odour intensity. The meat of Gascon bulls was adjudged second best in terms of tenderness, chewiness and the overall acceptance of the meat.

Beef, bulls, breeds, chemical composition, sensory characteristics

Introduction

Consumption of beef has fallen by about two-thirds in the Czech Republic since 1990, and is currently estimated at 9.4 kg per head of population per year (The Czech Statistical Office 2012). Domestic consumption therefore represents around just a half of that consumed by the average person in 15 EU countries. The causes for this decline can be found in a combination of a number of factors, of which the most important are the price (in comparison with poultry and pork), the varying quality of the product offered on the market, and information about the negative effect on human health of consumption of this kind of meat that is not always supported by hard facts. Certain changes in eating habits are also being seen, particularly among the younger generation, with a shift in the preference for and popularity of various kinds of meat in connection with lifestyle changes (Panovská et al. 2008). Moreover, the relatively low level of information among consumers about what to do with various cuts of beef and how to cook them properly does nothing to help increase beef consumption. Napolitano et al. (2010) state that the most decisive factors influencing the willingness of the consumer to buy beef include information on its origin and the method of breeding, feeding and treatment of the animals.

The breed of animals for slaughter is one extremely important factor determining the quality of meat. The cattle population in the Czech Republic is made up of around one-third Holstein cattle (dairy breed) and one-third Czech Fleckvieh cattle (dual-purpose breed), with the remainder made up of beef cattle breeds. At the present time, this group represents a diverse range of meat breeds bred either in pedigree form (a total of 16 beef breeds in the Czech Republic have their own stud book) or crossbred at various levels with dairy breeds, or interbred among various breeds. They make up a considerably heterogeneous group from the viewpoint of the composition of the carcass and the culinary quality of their meat. Animals for slaughter with a significant proportion of continental breeds can be fattened to a higher slaughter weight thanks to their lower degree of fat depositing, and are generally characterised by a higher slaughter yield and proportion of meat, particularly from the most valuable cuts. In contrast, individuals with a proportion of blood of British breeds (in particular Aberdeen Angus and Hereford) are more frequently slaughtered at a lower weight and their meat is characterised by more pronounced depositing of

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intramuscular fat – marbling. In view of the rather unsatisfactory profitability of fattening bulls, a considerable proportion of calves from beef cattle herds are sold directly for final fattening in other European countries. Even when breeders decide to continue to fatten weaned animals themselves, an increasingly large proportion of animals for slaughter are slaughtered abroad (Kvapilík 2010). The consequence of these facts taken together is the rather small range of high-quality beef produced in this country. In spite of the fact that certain breeders, processors and retailers now focus on the sale of meat of a certain breed, it is not presently usual for the ordinary consumer in the Czech Republic to have the chance of choosing a particular level of quality guaranteed by the breed of the animal when purchasing beef meat.

This study focused, therefore, on determining differences in the chemical composition and sensory quality of the meat of bulls of various productive types (breeds) fattened under the same conditions of housing and feed and slaughtered at the same age.

Materials and Methods

Samples of the meat of young bulls of four cattle breeds – Aberdeen Angus (AA), Gascon (GS), Holstein (H) and Czech Fleckvieh (C) – were evaluated during the experiment. The bulls were fattened at an experimental stable at the Institute of Animal Science and fed *ad libitum* an identical diet and slaughtered in the experimental abattoir at the Institute of Animal Science at the average age of 17 months and live weight of 657 ± 32.7 kg. The results for indicators of fattening and growth intensity and selected characteristics of slaughter value are published by Bureš and Bartoň (2012). The studied group included a total of 36 samples (9 from bulls of each breed) of sirloin (the *longissimus lumborum* muscle) taken 24 hours after slaughter from chilled right carcass sides at the level of the 9th to 11th rib. Each sample was divided into two parts following the removal of connective tissue and adipose tissue. Half the sample was used for the analysis of chemical composition (content of dry matter, proteins, fat and collagen), while the remaining part designated for sensory evaluation was vacuum-packed and, following six days of maturing in a refrigerator at a temperature of +4 °C, frozen and stored at a temperature of –50 °C for approximately 90 days. The samples of meat were defrosted at a temperature of +4 °C one day before sensory evaluation was performed and cut into slices 20 mm thick, which were then grilled on a double-sided glass-ceramic grill to a final internal temperature of +70 °C. This temperature was guaranteed by the use of a digital probe thermometer (Plate VIII, Figure 6).The edges of the grilled slices were removed and the slices cut into 20-mm cubes, which were kept at a temperature of +50 °C until submitted to the assessors. The sensory committee was comprised of 10 experienced and trained evaluators who assessed the samples in individual stalls preventing visual contact with the surrounding area (Plate VI, Figure 1). The samples could not be distinguished from one another by colour thanks to the use of red lighting. Assessment itself was conducted by means of a differentiation test (a quantitative descriptive method of a comprehensive and balanced design). The assessors were presented with individual sets of four samples from representatives of each of the breeds, slaughtered on the same day. A characterisation of the eight properties assessed is given in Table 1. A nine-point scale was used for the purposes of evaluation, with level one indicating the least acceptable properties and levels nine indicating the most favourable properties. A maximum of three sets were evaluated on any single day. The shear force of part of each chilled sample was measured approximately three hours after grilling on an Instron 3365 instrument using a Warner-Bratzler (WB) knife.

Table 1. Characteristics of evaluated properties

Descriptor	Characteristics of properties	Evaluation
Beef odour intensity	Strength of aroma typical for cooked beef	before putting sample in the mouth
Pleasantness of aroma	The presence of an aroma typical of cooked beef	before putting sample in the mouth
Tenderness	Force required to bite through sample with the molars	after 1 or 2 bites
Beef flavour intensity	The presence of a flavour typical of cooked beef	after 3 or 4 bites
Fibrosity	Fineness or coarseness of fibres	after 3 or 4 bites
Juiciness	Amount of liquid released from mouthful during biting	after 3 or 4 bites
Chewiness	Force required to chew mouthful before swallowing	10 to 15 bites
Overall acceptance	Personal preference of assessors between samples presented	following consumption of sample

The data obtained was evaluated by the MIXED procedure in the statistical program SAS. The breed of the animals, supplemented in the case of the sensory analysis by the random effect of the day of evaluation and the assessors, was incorporated into the model equation as a fixed effect. The values of the correlations (Pearson's correlation coefficients) between the chemical composition of the meat and the sensory analysis were calculated using the CORR procedure.

Results and Discussion

Table 2. Chemical composition and physical properties of sirloin

	Breed				
	AA	GS	H	C	Significance
Dry matter ($g.kg^{-1}$)	271.5 ^{A}	255.1 ^{B}	266.3 ^{A}	254.6 ^{B}	< 0.0001
Proteins ($g.kg^{-1}$)	214.1	221.2	218.7	220.5	0.1723
Fat ($g.kg^{-1}$)	36.2 ^{A}	15.0 ^{B}	27.7 ^{A}	16.9 ^{B}	< 0.0001
Total collagen ($g.kg^{-1}$)	4.56	4.30	4.59	4.53	0.9011
Soluble collagen (% of total collagen)	24.9	22.2	22.3	26.7	0.4718
Thawing loss (% of weight)	5.5	6.0	7.5	7.4	0.2835
Grilling loss (% of weight)	14.2	14.8	16.6	13.0	0.2793
Total loss (% of weight)	19.7	20.8	24.0	20.4	0.1538
Shear force WB (N)	36.0 ^{A}	46.8	58.5 ^{B}	49.8	0.0460

^{A,B,C}Means within a row with different superscripts significantly differ ($P < 0.05$)

It is clear from the results in Table 2 that the most pronounced differences in the chemical composition of the meat of individual breeds were found in the content of dry matter and intramuscular fat. The differences in dry matter content were caused, first and foremost, by the differing content of fat, of which there was more than twice as much in the meat of AA bulls than in GS and C bulls(Plate VIII, Figure 7). This finding corresponds to the results produced by other studies (Bureš et al. 2006; Cuvelier et al. 2006) and is no surprise, since the AA breed is characterised by higher fat depositing, and sufficient marbling of sirloin is considered desirable in countries in which the breed is most widespread. In contrast, GS and C bulls are representatives of breeds of continental Europe, where there is a preference for a lower amount of fat in the carcass and fattening to a higher weight at slaughter.

We did not discover any significant differences in the content of protein or collagen in our study. Collagen, as the basic building block of connective tissue, influences the textural characteristics of the meat. According to certain authors (Christensen et al. 2011), the proportion of soluble and insoluble collagen is more important in terms of the tenderness of the meat than the absolute quantity of collagen. Even here, however, only minimal differences between the individual breeds were observed in our study. In contrast, considerable differences were found during assessment of the force required to cut the muscle fibres in grilled meat. The lowest shear force of WB 36 N (a force approximately corresponding to the action of a mass of 3.6 kg) had to be exerted on steaks in group AA, while the value measured on the toughest samples of H bull meat amounted to 59 N. The weight losses in the samples caused by chilling and grilling were largest in Holstein bulls, though the differences determined were again neither particularly large nor statistically conclusive.

The results of the sensory analysis are given in Plate VI, Figure 2. With the exception of the evaluation of beef odour intensity, for which significant differences between the individual breeds were not found, the meat of AA bulls differed extremely markedly ($P < 0.001$) in terms of all properties studied and received the most favourable evaluation.

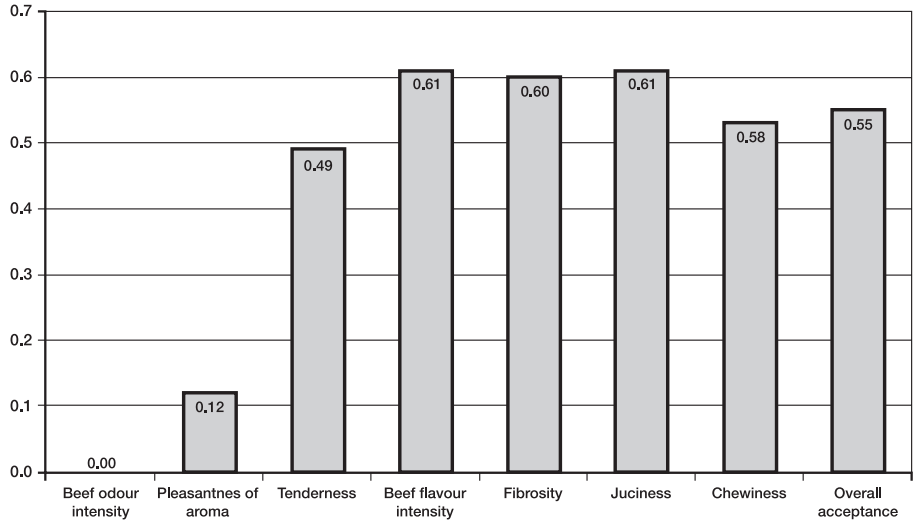

Fig. 3. Correlation coefficients between intramuscular fat content and sensory characteristics

Samples from GS bulls received the second best evaluation for tenderness ($P < 0.001$), chewiness and overall acceptance, while the meat of breed C and H bulls received very similar assessments for the majority of properties. Group H was ranked in second place in the assessment of juiciness. The evaluation of the samples of meat was influenced to a considerable degree for the majority of the characteristics studied by the content of fat. The values of correlation coefficients between the quantity of intramuscular fat and sensory evaluation are given in Figure 3. The highest values ($r = 0.61$) were recorded identically for juiciness and beef flavour intensity. The content of fat

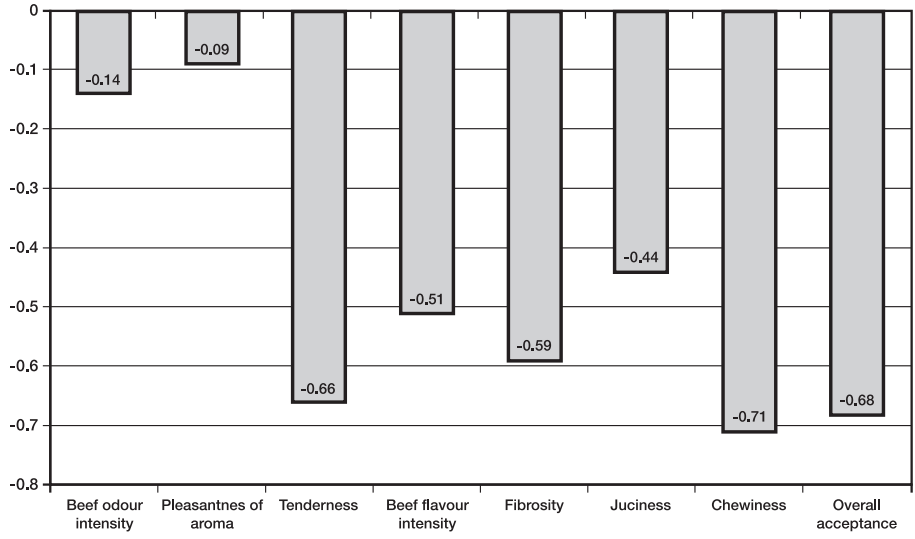

Fig. 4. Correlation coefficients between Warner Bratzler shear force and sensory characteristics

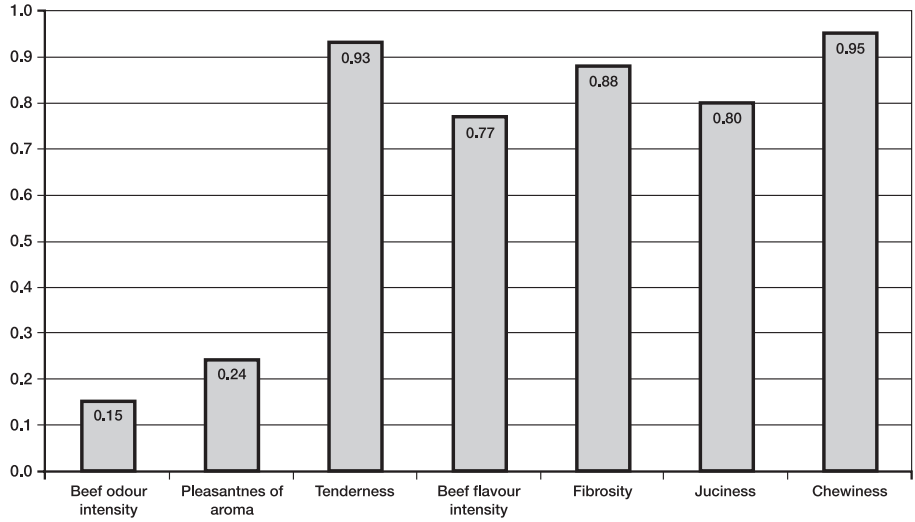

Fig. 5. Correlation coefficients between overall acceptance and other sensory characteristics

in meat is considered one of the decisive factors influencing the sensory quality of the meat, particularly where there are significant differences between the samples evaluated (Hocquette et al. 2010). This relationship was also observed in our previous work (Bureš et al. 2008), in which the meat of heifers containing almost twice as much intramuscular fat received a considerably more favourable sensory evaluation than the meat of bulls.

Statistically conclusive values of correlation coefficients were also found between the objectively determined WB shear force and the characteristics evaluated by the sensory panel, particularly those describing the textural properties of the meat (Figure 4). Negative values of correlation coefficients indicate that the point score for the given sensory properties increases with falling shear force. This finding is confirmation of the relatively good ability of the assessors to differentiate properties of meat texture, and is in agreement with the findings of Caine et al. (2003), who also give conclusive negative values for the correlation between the WB shear force and the tenderness of beef steaks evaluated in sensory terms.

The evaluators assessed the final property – overall acceptance – on a scale of one to nine in an attempt to express their personal preference, i.e. which sample they would select of those presented if they were asked to choose between them. The results of the correlation analysis given in Figure 5 indicate that the closest values between the overall evaluation and the other characteristics were for tenderness and chewiness. This means that these were the properties that proved decisive in shaping the preferences of the evaluators. The beef odour intensity or pleasantness of the aroma, in contrast, was not so important to determination of the overall order in which the samples were placed.

Conclusions

Significant differences in the content of intramuscular fat and its organoleptic properties were found in the meat of bulls of four cattle breeds fattened under identical conditions and slaughtered at the same age. The meat of Aberdeen Angus bulls obtained the most favourable assessment for all the sensory characteristics evaluated with the exception of beef odour intensity. The meat of Gascon bulls was ranked second in terms of tenderness,

chewiness and overall acceptance. Statistically conclusive values of correlation coefficients were found between the content of intramuscular fat and sensory characteristics, and similarly between the WB shear force measured instrumentally and the sensory properties of the meat. The differences determined in the culinary quality of the meat of bulls of individual domestic types published in this work may contribute towards increasing the amount of information available to both producers and consumers.

Acknowledgement

This study has been supported by the Ministry of Agriculture of the Czech Republic (project MZE 0002701404).

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Fig. 1. The sensory laboratory is equipped with separate stalls for each assessor

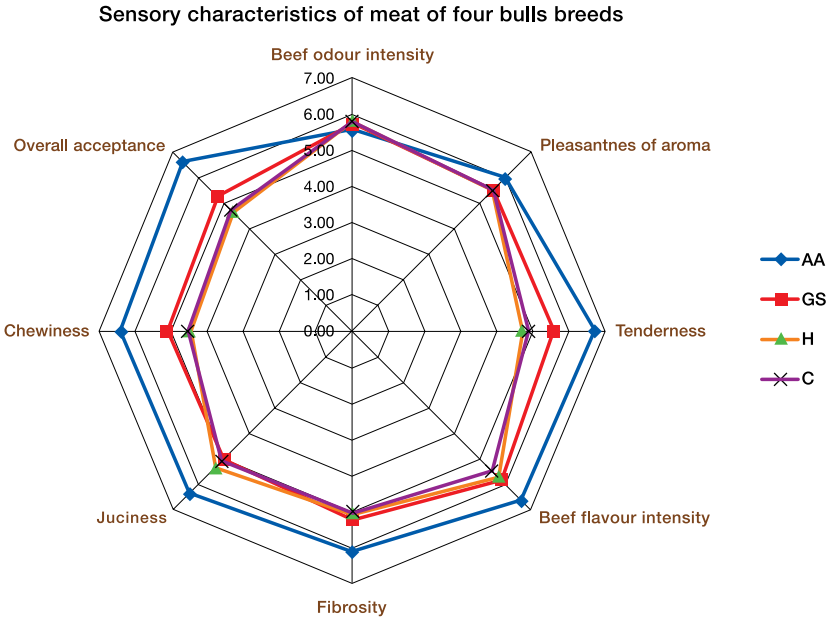

Fig. 2. Sensory characteristics of beef from four different breeds

Plate VII

Fig. 6. Grilling to a final internal temperature of 70 °C is determined by a digital temperature probe

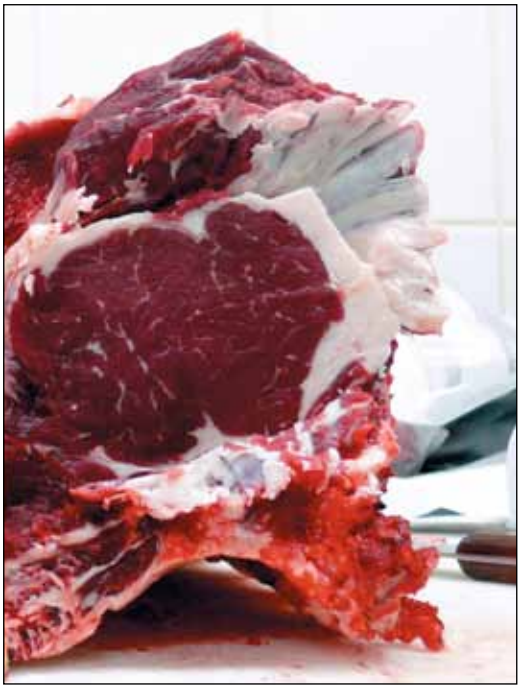

Fig. 7a and 7b. The difference in sirloin marbling between GS bulls (Fig. 7a) and AA bulls (Fig. 7b) can be seen with the naked eye