EFFECT OF LINSEED AND GRASS FEEDING ON THE FLAVOUR PROFILE AND TASTE-PANEL EVALUATIONS OF BEEF FROM BELGIAN BLUE DOUBLE-MUSCLED BULLS

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Background

Nowadays, a lot of research is performed aiming at increasing the n-3 polyunsaturated fatty acid content (PUFA) of meat to better meet human nutritional guidelines with respect to the P/S and n-6/n-3 ratios. Increasing the n-3 PUFA content of beef can be achieved by feeding fish oil/algae, linseed (oil) and/or grass or grass silage to cattle (see review Raes et al., 2004). However, it has been demonstrated that increasing the n-3 PUFA content may affect meat flavour. This effect seems to depend on the n-3 PUFA level in the meat and the feed source. Beef from grass-fed animals may elicit a typical grass-like flavour (Melton, 1990). Both C20:5n-3 and C22:6n-3 may cause an undesirable fishy flavour above certain levels, which is observed by consumers after heating the meat (Mottram, 1998). Also the heating method affects flavour profiles, however, most research on beef flavour has been done after moist cooking, and few references are available on flavour profiles of roasted or grilled beef (Elmore et al., 2004; Raes et al., 2003a).

Objectives

The aim of this study was to evaluate the flavour profile of meat from bulls fed a C18:3n-3 rich diet using linseed and/or grass or grass silage. The flavour profile as chemical components was measured by gas chromatography – mass spectrometry. Flavour was also evaluated by a semi-trained taste-panel.

Materials and methods

Experimental design

Thirty-one Belgian Blue double-muscled young bulls (mean (sd) live weight at start 339 (44.4) kg) were fed different feeds aiming at increasing the n-3 intramuscular fatty acid content (as fully described by Raes et al., 2003b), and studying the effects on oxidative stability and flavour of the meat. The animals were divided in 4 groups receiving different diets during three subsequent phases (last growing phase, prefattening phase and fattening phase). The diets differed according to the main fat source in the concentrate as well as in the type of roughage, as shown in Table 1. To increase the n-3 fatty acid content in the muscle tissue, linseed was added as the main C18:3n-3 source in the concentrates, and grass or grass silage as a C18:3n-3 roughage source. Animals were slaughtered at a mean (sd) live weight of 681 (26.3) kg. After cooling the carcasses for 24 h, the *longissimus thoracis* (LT) was sampled for flavour profile analysis, while the LT, *semitendinosus* (ST) and *triceps brachii* (TB) were sampled for taste-panel evaluations. The meat samples were vacuum packed and aged for 14 days at 2°C. After ageing, the samples were stored at –18°C until analysis.

Analyses

Taste-panel evaluations

Sensory characteristics ie., tenderness, juiciness, flavour intensity and flavour preference, were evaluated by a trained taste panel of ten members (22-55 years of age). In the first series of sessions, tenderness and juiciness were evaluated, while in the subsequent series of sessions flavour intensity and flavour preference were scored. All evaluations were performed for all three muscles with the exception that flavour preference of LT muscle was not ranked. Two servings were provided at a session. Each serving included one sample (from the same muscle) of each of the 4 feeding groups. As in Belgium, grilling is a very common heating method for beef steaks**,** samples (3x3x2 cm) were grilled for 2 minutes on a double-contact grill and served on pre-heated plates for sensory evaluation. The panellists were asked to assess tenderness and juiciness on

an 8-point scale. The values of 1 and 8 correspond with extremely tender or juicy and extremely tough or dry, respectively. Flavour intensity and flavour preference were evaluated using a ranking test. The values of 1 and 4 correspond to the lowest and the highest flavour intensity or flavour preference, respectively.

Flavour analysis

For each group, 3 samples of the LT were grilled and extracted using the Likens-Nickerson extraction. The aroma compounds were collected and analysed by gas chromatography-mass spectrometry (GC-MS) as described by Raes et al. (2003a). Semi-quantitative data of the flavour compounds were obtained by relating the peak intensities to the intensity of nonane, added to the dichloromethane phase as an internal standard.

Table 1. Composition of the diets for the different feeding phases depending on the feeding group

	Group C_1 (n = 7)	Group GC_2 (n = 8)	Group GC_3 (n = 8)	Group MC_4 (n = 8)
Last growing phase (70 d)				
Concentrate	----------	+ linseed	----------	– linseed
Roughage		Fresh grass		Maize silage
Prefattening phase (56-98 d)				
Concentrate	-------	+ linseed	-------	+ linseed	– linseed
Roughage		Whole triticale silage		Grass silage	Maize silage
Fattening phase (42-190 d)				
Concentrate	– linseed	+ linseed	+ linseed	+ linseed
Roughage	–	Grass silage	Grass silage	Maize silage
Concentrate/roughage ratio (on DM basis)	100/0	80/20	70/30	80/20

Statistical analysis

Data were subjected to analysis of variance (ANOVA), using Duncan as post-hoc test (SPSS 9.0). Principal component analysis (PCA) was carried out using data of the flavour profile analysis.

Results and discussion

In Figure 1, a PCA bi-plot of the flavour volatiles of the LT muscle and the average feeding group scores are shown. Group MC_4 is situated in an area where little volatiles were found, while group GC_2 show a strong association with derivatives of pyrrol and furan. Group C_1 and group GC_3 are situated in the areas characterised by pyrazines, branched and aromatic aldehydes, saturated aldehydes as well as sulphur containing compounds. In Table 2, the semi-quantitative analysis of the volatile categories is given per feeding treatment. Significant differences between feeding groups were only observed in pyrrol and furane derivatives, while no differences were found for the other volatiles. In grilled products, the pyrazines are important flavour compounds formed by Maillard reaction and Strecker degradation. No differences were observed between the feeding groups in the amount of these volatiles, which is in agreement with Elmore et al. (1999) who reported that the dietary fat source had no effect on the production of pyrazines. Overall, the amount of volatiles formed during heating of Belgian Blue beef is small, and lower compared to that originating from cattle with a higher degree of fat and/or different feeding regime (Raes et al., 2003a).

As it is known that flavour evaluations by a taste-panel can be influenced by differences in tenderness and juiciness, both these parameters were evaluated by the taste-panel. No differences in tenderness could be observed between the feeding groups (Table 3). For juiciness, however, the taste-panel evaluated the LT and TB samples from the groups GC_2 and GC_3 significantly juicier than those from the groups C_1 and MC_4. The analytical flavour profile corresponds to the results observed by the taste-panel (Table 3). Indeed, the taste-panel appointed the lowest flavour intensity to meat from animals of group MC_4, which is in agreement with the flavour profiling (Figure 1), the differences between the feeding groups being small, however.

A non-significantly higher amount of saturated aldehydes was found in the group MC_4 compared to the other groups, due to higher amounts of hexanal ($P = 0.076$) and 2,4-decadienal ($P = 0.128$). Both these volatiles originate from oxidation of n-6 PUFA. A significantly higher amount of 1-octen-3-ol ($P = 0.010$), formed during oxidation of C18:2n-6, was found in group MC_4 compared to the other groups. This corresponds with

the fatty acid analysis of the beef, where MC_4 showed a higher n-6 PUFA content than GC_2 and GC_3 (Raes et al., 2003b). Similarly, Elmore et al. (2004) found higher concentrations of hexanal and 1-octen-3-ol for concentrate fed animals compared to silage fed animals.

Concerning flavour preference, the taste-panel had the lowest appreciation for the steaks from group C_1 (Table 3). Thus, the flavour may have been positively affected by the linseed in the finishing diet.

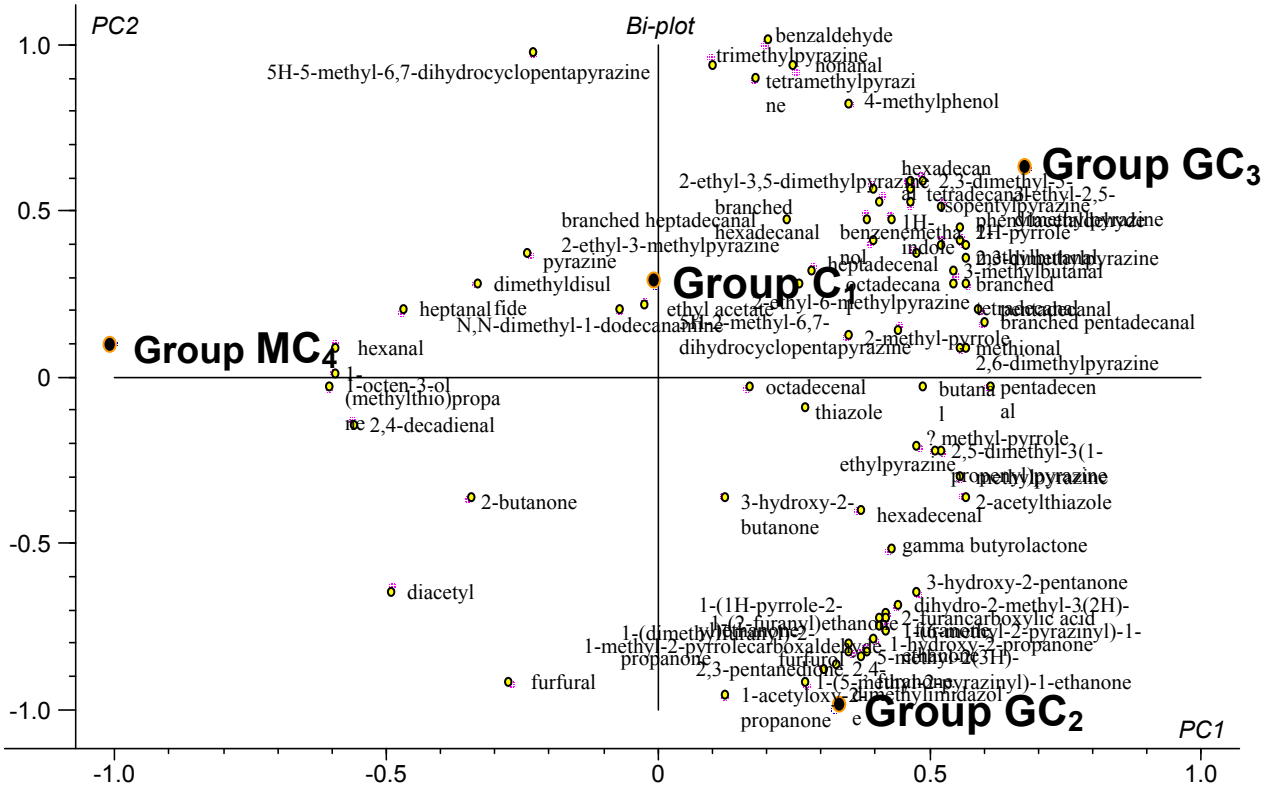

Figure 1. PCA bi-plot of the GC-MS flavour profile analysis of *longissimus thoracis* samples of the different feeding groups

Table 2. Semi-quantitative analysis of the volatile classes (µg/kg meat) for the different feeding groups[1]

	Group C_1	Group GC_2	Group GC_3	Group MC_4	P
saturated aldehydes	46	42	45	55	0.303
branched and aromatic aldehydes	420	375	443	322	0.069
higher saturated aldehydes	14241	11956	14705	9832	0.146
higher unsaturated aldehydes	4431	4269	3953	3283	0.164
alcohols	13	13	16	23	0.199
ketons	1136	1109	885	868	0.579
pyrrol derivatives	89^{ab}	122^{a}	90^{ab}	56^{b}	0.018
pyrazines	418	422	485	403	0.273
furan derivatives	150^{a}	184^{b}	153^{a}	150^{a}	0.002
thiazol derivatives	19	21	21	18	0.598
other nitrogenous compounds	54	66	72	66	0.090
sulphur containing compounds	70	67	70	55	0.385
esters	27	31	25	25	0.171

[1] Mean values of three observations
[a,b] Means with a different superscript are significantly different ($P < 0.05$)

Table 3. Mean values (n = 7) for tenderness[1], juiciness[1], flavour intensity[2] and flavour preference[2] scored by a semi-trained taste-panel from samples of the different feeding groups

	Group C1	Group GC2	Group GC3	Group MC4	P
Tenderness					
LT	3.2	2.9	2.8	3.2	0.338
ST	4.6	4.1	4.4	4.2	0.490
TB	3.9	3.6	3.6	3.7	0.625
Juiciness					
LT	4.0^{ab}	3.6^{ab}	3.5^{a}	4.2^{b}	0.025
ST	4.2	4.2	4.1	4.2	0.970
TB	4.0^{a}	3.2^{b}	3.6^{ab}	3.9^{a}	0.011
Flavour intensity					
LT	2.4	2.5	2.8	2.2	0.121
ST	2.7^{a}	2.8^{a}	2.5^{a}	2.0^{b}	0.002
TB	2.5	2.7	2.6	2.2	0.236
Flavour preference					
ST	2.2	2.7	2.5	2.6	0.365
TB	2.0^{a}	2.8^{b}	2.5^{b}	2.7^{a}	0.003

[a,b] Means with a different superscript are significantly different ($P < 0.05$)
[1] Evaluation on a 1 to 8 scale where 1 = extremely tender or juicy, and 8 = extremely tough or dry
[2] Evaluation using a 1 to 4 ranking test where 1 = lowest intensity or preference, and 4 = highest intensity or preference

Conclusions

Relatively small differences in the flavour profile were detected in grilled meat from Belgian Blue double-muscled young bulls fed rations differing in the presence of linseed in the concentrate and the use of grass or grass silage as roughage. However, the semi-trained taste-panel was able to observe flavour differences between the feeding groups.

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