Grassy Odour in Beef

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**Abstract**

There were used 6 bulls fed by corn silage (42,4 %), lucerne silage (40,2), corn grain moistened (10,3), wheat grain (5,8), and mineral mix with urea (1,1%) to characterize the odour quality by olfactometry. Every beef sample was assessed by 6 evaluators. Although meat odour is logically the most expected, the grassy odour was the most presented odour and mostly identified as hexanal. Hexanal was presented in every sample and it was identified certainty and it was always described as grassy. Hexanal is commonly found in beef, it is a product of oxidation of oleic and linoleic acids. Because of it some researchers identified it as the unpleasant compound but others as a pleasant compound as we did. However, hexanal is presented as in the grain-fed so in the forage-fed ruminant meat in literature. It remains the question of hexanal influence on beef palatability.

**Keyword:** Beef Quality; Hexanal; Grassy Odour; Oxidation

**Material and Methods**

There were selected 6 young bulls from the experimental unit of the Institute of Animal Science. Bulls were fed by corn silage (42,4 %), lucerne silage (40,2), corn grain moistened (10,3), wheat grain (5,8), and mineral mix with urea (1,1%). There was taken longissimus lumborum from everyone for the analysis. The samples were aged for 15 days and frozen at -20 °C until unfrozen them before the day of analysis. Before its own analysis 6 assessors were selected and trained. Testing first samples we noticed hexanal as the most important compound. To determine assessor’s perception defect was used the triangular test. We decided to be realized it with hexanal using recommended concentration threshold of 5.87 ppm.
ppm [10]. We did a dilution test to determine the threshold but also possibly changes in odour perception which were not detected. Than the assessors were trained using five steps: introduction of GC-O methods to the panelists during 2 days of theory lectures; vocabulary training using standard compounds; training with reference mixture; sniffing the product of interest; monitoring and further training of the panel twice per month using reference mixture.

The vocabulary was set according to literature as odours that may appear in a beef sample and using examples [11]. The sample were grilled at 200°C to get 70 °C of internal temperature of meat measured by thermometer, homogenized, weighed 2 grams of it and added 4 ml of water to 10 ml vial to simulate the eating process. There were prepared 6 samples of one meat to every assessor. There were used SMPE sorption on polydimethylsiloxane/divinylbenzene (PDMS/DVB) pink fiber of 65 μm film thickness from Supelco (Madrid, Spain). The sample were sorbed 40 minutes and then placed into gas chromatograph to analyze. To determine the linear retention index, the C7-C40 saturated alkane mix (Supelco) was used. Ultrapure water (generated using Aqual® 35, Aqual, Brno, Czech Republic) was utilized for extraction. For qualitative and quantitative analyses, multidimensional gas chromatography coupled to a flame ionization detector and a mass spectrometry detector (MDGC/FID/MS) was used. The MDGC/FID/MS system was also equipped with GC-2010 and the autosampler AOC20i (Shimadzu, Kyoto, Japan). The first dimension of the chromatographic system was the GC-FID system.

A fused-silica capillary SLB-5ms column (30 m, i.d. 0.32 mm, 1.0 μm d.f., Supelco, USA) was used for the separation. The samples (1 μL) were injected in the inlet in the split less mode and were heated at 250 °C. He (purity 5.0) was used as the carrier gas with a linear velocity of 1.14 mL/min (115.9 kPa). The flame ionization detector (FID) was heated at 260 °C. The temperature program for the first dimension (GC1) started at 120 °C (0 min), and then, the temperature was increased to 250 °C at a heating rate of 15 °C/min, after which this temperature was held for 5.88 min. The second column (GC2) was SPB-50 (30 m, i.d. 0.35 mm, 0.25 μm d.f., Sigma-Aldrich/Merck, Germany). In GC2, the same temperature program as that in GC1 was used. The total run time was 14.55 min. A mass detector (GCMS-QP2010 Ultra, Shimadzu, Kyoto, Japan) was connected after this second column. Selected peaks were switched to the second dimension via the Deans switching device (SHIMADZU 221-71468-91 Switching Assy, Shimadzu, Kyoto, Japan) with 100% switching recovery and a switching pressure of 50 kPa.

During the analysis, the whole MDGC-MS system was controlled using the software MDGC Solution 1.01.00, a GC Solution 240.00 from the same company. The qualitative analysis was carried out using the mass detector (MS). A transfer-line in the MS was heated at 260 °C and the ion source temperature was set to 220 °C. For the qualitative analysis, the MS detector operated in the electron ionization (EI) mode at −70 eV: a mass range of 30-300 amu was obtained, with an acquisition rate of 10 Hz. For quantification there were used isothermal desorption hold on 200°C during 43 min using 2,6-dichloroanisole (≥99%, Sigma-Aldrich, Merck, USA); Butanoic acid, 2-methyl-, methyl ester (99%, Sigma-Aldrich, Merck, USA) as internal standards and 44, 56 and 41 fragment peak to determine the peak area. To determine the statistical difference, there were used GLM procedure and MIXED procedure with the day as random effect included. The data presented in the tables are expressed as the smallest average squares (LSM) with its standard error (SEM).

**Results**

There were realized the fatty acid composition of the feeding components with a noticeable fat content to justify the fatty acids oxidation as the cause of the aldehydes release. The fatty acid composition is mentioned in the Table 1. Other fatty acids were presented in smaller content than 1 mg/kg of meat. Thus, a noticeable hexanal content was assumed and grassy odour was expected (Table 1). In the part of olfactometry, there were obtained three types of results: description of separated compounds, peak area of all compounds desorbed and quantification also. The most frequent description of the volatile compound was the stale (wet or moldy cellar/textile; moldy or spoiled food) and lemon or sour and some unidentified unpleasant smell probably incurred during the sample storage followed by the sum of fruit mostly non recognized type (banana, plum, berries, apricot, fermented fruit) followed by the sample storage followed by the sum of fruit mostly non recognized type (banana, plum, berries, apricot, fermented fruit) followed by lemon or sour and some unidentified unpleasant smell probably incurred during the sample storage followed by the sum of fruit mostly non recognized type (banana, plum, berries, apricot, fermented fruit) followed by the calculated peak area of all compounds analysed together. We can notice an importance of hexanal area. In the Table 1 there are the significant data about quantification of grassy odour. There were determine 15 compounds of grassy odour. The largest peak area was determine as the hexanal peak area (Figures 1 & 2) (Table 2).

**Table 1:** The most important fatty acid of the feeding components.

| Fatty Acids Composition [mg/kg of meat] | Wheat Grain | Corn Grain Moistened |
|----------------------------------------|-------------|----------------------|
| Linoleic acid                          | 59,015      | 53,374               |
| Oleic acid C 18:1-n9                    | 15,065      | 27,083               |
| Oleic acid C 18:1-n7                    | 1,344       | 2,318                |
| Palmitic acid                          | 16,796      | 12,380               |
| α-Linolenolic acid                      | 4,477       | 1,424                |
| Stearic acid                           | 1,174       | 1,990                |

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Table 2: Compounds of grassy odour [method used for calculation: LSM].

| Compound  | Retention time | Retention index | Estimate | SE     | P-value |
|-----------|----------------|-----------------|----------|--------|---------|
| Compound 1| 15.108         | 737             | 36155    | 17189  | 0.0516  |
| Pyridine  | 15.572         | 750             |          |        |         |
| Compound 3| 16.201         | 771             |          |        |         |
| Hexanal   | 17.23          | 804             | 455706   | 103563 | 0.0004  |
| Compound 5| 20.092         | 905             |          |        |         |
| Compound 6| 22.311         | 999             |          |        |         |
| Nonanal   | 24.314         | 1089            | 132253   | 17140  | <.0001  |
| Compound 8| 25.002         | 1121            |          |        |         |
| Compound 9| 26.071         | 1170            |          |        |         |
| Dodecane  | 26.188         | 1175            | 3979.58  | 861.76 | 0.0003  |
| Compound 11| 26.321        | 1185            |          |        |         |
| Compound 12| 27.7          | 1248            |          |        |         |
| Decanoic acid | 28.802     | 1316            | 6037.41  | 2264.40| 0.0169  |
| Compound 14| 29.453         | 1349            |          |        |         |
| Compound 15| 31.02          | 1437            |          |        |         |

Figure 1: Frequency of odours [number of evaluations].

Figure 2: Peak area of the compounds [intensity due to the base peak].
Discussion

The grassy odour is an important odour of beef. There were analyzed hexanal as the most important compound of the grassy odour. The hexanal content should be related to the oxidation of oleic and linoleic acid [12]. It was determined the highest content of these acids in the fat of animal feeding, so it was expected certain content of hexanal. It is assumed that the lipid oxidation of meat is unpleasant and arises off-flavours [10]. But the grassy odour of hexanal was pleasant for the assessors. Also, it’s a compound commonly found in beef and its content is expected even in the most favorite beef breeds. For example, there were set an experiment realized with Angus breed finished on a mixed ration including wheat and potato waste for 150 days, grass-fed Angus and grass-fed Wagyu breed. These two breeds are known to have the highest content of intramuscular fat so its pretended that the content of oleic and linoleic acid is also high and subsequently causes the increased content of hexanal. In all of three cases the hexanal had the third highest content of all the volatiles determinate, 33,4 mg/kg of meat, 17,7 mg/kg of meat and 33,5 mg/kg of meat [9].

Conclusion

As the conclusion, grassy odour is an important meat odour. It may provide from hexanal which is damned by some researchers as the undesirable product of oxidation, but assessors assessed it as pleasant grassy odour. It was the most intensive compound recognized and it had significative representation in the meat.

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