SOLID PHASE MICROEXTRACTION EVALUATION OF KEY AROMA COMPOUNDS IN COOKED BEEF MEAT AS INFLUENCED BY BREED AND DIET

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Background

To date more than 500 volatiles contributing to the odour of cooked meat have been identified. The Maillard reaction, thiamin degradation and lipid oxidation are the main reactions leading to the development of the flavour of meat during the heating process. The overall odour profile of cooked meat depends on the species, the breed, the animal's diet, the cooking method and some other parameters such as meat processing. Among those, breed and diet are factors of importance as they induce different chemical compositions of meat. Solid Phase Microextraction (SPME) is a convenient tool for the isolation of volatile compounds in foods. Its application to the screening of aroma compounds in cooked pork meat has been reported by Elmore et al. (2000).

Objectives

The objective of this study was to compare by SPME combined with gas chromatography-mass spectrometry (GC-MS) the peak areas of selected key aroma compounds in the headspace of cooked beef meat from differently fed Belgian Blue (BB) and Aberdeen Angus (AA) bulls.

Methods

BB and AA bulls were offered a fattening diet based either on cereals-rolled barley and crushed maize (cereal based) - or on dry sugar beet pulp (pulp based) and supplemented with soja bean meal and linseed meal as protein source. Muscles (*longissimus dorsi*) from BB and AA bulls were trimmed of subcutaneous fat, vacuum packed and stored at -18°C. Thirty five g of sample was cut in small pieces, frozen by liquid nitrogen and ground until a powder was obtained. One g of this powder was placed in a 40 ml headspace vial sealed with PTFE/silicone septum for analysis. The meat was cooked at 150°C in a silicone bath for 20 min, cooled to 0°C in a water/ice bath for 10 min, and equilibrated at 60°C for 10 min. Extraction was performed using a divinylbenzene-carboxen-polydimethylsiloxane (DVB-CAR-PDMS) SPME fiber for 20 min at 60°C. All analyses were performed using a Varian Saturn 2000 ion-trap mass spectrometer fitted with a Varian CP 3800 gas chromatograph. The SPME fiber was thermally desorbed at 250°C in the injector port for 2 min in the splitless mode, the split valve being opened after 2 min (split ratio 10). During desorption the oven was held at 35°C. A Rtx-5MS column (60m x 0.25 mm i.d., 0.5µm film thickness, Restek, Bellefonte, PA) was used to separate the volatile components of the cooked meat. After desorption, the oven was held at 35°C for 3 min, heated to 50°C at 10°C/min, then raised to 200°C at 10°C/min and finally by 10°C to 250°C and held for 10 min at this temperature. Helium was used as carrier gas with a constant flow of 1.5 ml/min. Data were collected using the Saturn version 5.2 software package. Compounds were semi-quantified using total ion count (TIC) and results were reported as peak areas. Retention index values were calculated and compared to those of published values (Kondjoyan & Berdagué, 1996). Data were subjected to analysis of variance (ANOVA). Means were compared by student t-test, the differences being considered as significantly different at $p<0.05$.

Results and discussion

The peak areas of 34 volatile flavour compounds extracted from the headspace of BB and AA cooked meat were compared. The influence of the two different diets on the production of volatiles during cooking was also studied (Table 1). ANOVA showed a significant effect of breed on 22 compounds in the pulp based diet group and on 26 compounds in the cereal based diet group. Diet influenced significantly the number of volatiles in the two breeds: 24 volatiles presented different peak areas in the BB group and 19 in the AA group. It appeared that the total amount of volatiles extracted from the headspace of meat from cereal fed animals was larger than from the headspace of pulp fed animals. Surprisingly, the total amount of volatiles extracted from AA was lower than from BB for the two diets. Those latter results have to be related to the chemical composition of meat and more precisely to the fat content. BB is usually considered as a "low fat content" meat with the correlated loss of flavour development. In this study, it seems that BB meat presented larger or equivalent amounts of key volatile flavour compounds than AA.

Conclusions

The volatile composition of cooked beef meat was influenced by breed when the animals were fed a similar diet. Significant differences in the volatile composition between BB and AA were also shown in each diet. More volatiles were released from the meat of cereal fed animals. Furthermore, it was shown that the total amount of key volatile flavour compounds extracted from the cooked meat of BB was larger than the one from AA for the two types of studied diets.

Pertinent literature

Elmore J. S., Mottram D. S., & Hierro E. (2000). Two-fibre solid-phase microextraction with gas chromatography-mass spectrometry for the analysis of volatile compounds in cooked pork. J. Chromatogr. A, 905, 233-240.
Kondjoyan N., & Berdagué J. L. (1996). A compilation of relative retention indices for the analysis of aromatic compounds. Saint-Genes Champanelle: Edition du Laboratoire Flaveur.

Acknowledgements

The authors wish to thank the Fonds National pour la Recherche dans l'Industrie et l'Agriculture (Bruxelles, Belgium) for funding.

Table 1. Effect of breed and diet on volatile flavour compounds of cooked beef meat

Retention Index[1] (RI)	Compound	Peak area (TIC)			
		Pulp based diet		Cereal based diet	
		Belgian Blue	Aberdeen Angus	Belgian Blue	Aberdeen Angus
<600[2]	Methanethiol	134352^{a}	91605^{b}	176674^{c}	114776^{d}
<600	Carbon disulfide	1116590^{a}	670281^{b}	1254898^{a}	1601762^{c}
<600	2,3-Butanedione	83045^{a}	76337^{a}	85306^{a}	95270^{a}
601	2-Butanone	177686^{ab}	155735^{a}	254348^{b}	173709^{a}
655	3-Methylbutanal	196908^{a}	238106^{bc}	224669^{ab}	273189^{c}
666	2-Methylbutanal	180988^{a}	230548^{bc}	216428^{b}	254641^{c}
696	2,3-Pentanedione	348509^{a}	333929^{a}	538779^{b}	396647^{a}
700	Pentanal	168649^{ab}	138317^{b}	305090^{c}	185029^{a}
704	2-Ethylfuran	82227^{a}	69555^{a}	198847^{b}	131775^{c}
741	Pyrazine	17256^{a}	12882^{b}	34311^{c}	15102^{ab}
751	Dimethyl disulfide	24868^{a}	19728^{a}	27607^{a}	34806^{b}
758	Pyrrole	34058^{a}	23390^{b}	49750^{c}	24348^{b}
802	Hexanal + mesityl oxide	702595^{a}	460114^{b}	1413325^{c}	865070^{a}
831	Methylpyrazine	102323^{a}	91041^{a}	138119^{b}	104486^{a}
839	Furfural	107436^{a}	83017^{b}	156355^{c}	123074^{a}
893	2-Heptanone	136134^{a}	69230^{b}	229699^{c}	155170^{a}
904	Heptanal	321285^{a}	954427^{b}	551413^{c}	742262^{d}
912	3-Methylthiopropanal	7115^{a}	5720^{a}	9453^{b}	7984^{ab}
920	2,5-Dimethylpyrazine	247509^{a}	247912^{a}	219420^{a}	269995^{a}
981	2-Octen-1-ol	564304^{a}	295874^{b}	940667^{c}	629274^{a}
984	2-Methyl-3-octanone	134011^{a}	101015^{a}	290234^{b}	195024^{c}
994	2-Octanone	54231^{ac}	39157^{a}	101113^{b}	68300^{c}
996	2-Pentylfuran	4343465^{a}	1571508^{b}	6726349^{c}	4269738^{a}
1006	Octanal	459575^{a}	667182^{b}	692436^{bc}	770084^{c}
1012	Trimethylpyrazine	176492^{a}	144469^{b}	138019^{b}	183869^{a}
1031	2-Acetylthiazole	43979^{a}	37891^{b}	80261^{c}	61219^{d}
1057	Benzeneacetaldehyde	248008^{a}	318872^{b}	293222^{ab}	290834^{ab}
1064	2-Octenal	299960^{a}	331424^{ab}	406875^{c}	365289^{bc}
1109	Nonanal	2126315^{a}	3067625^{b}	2971374^{b}	3484677^{b}
1167	2-Nonenal	183947^{a}	394938^{b}	199557^{a}	303100^{c}
1226	2,4-Octadienal	n.d.^{a}	23734^{b}	n.d.^{a}	12804^{c}
1331	2,4-Decadienal	391866^{a}	183516^{b}	295344^{ac}	247595^{bc}
1400	Tetradecane	544287^{a}	43169^{b}	819866^{c}	189877^{d}
1500	Pentadecane	404958^{a}	18830^{b}	736856^{c}	76726^{b}
	CV[%][3]	17	17	18	22

Within each row, means with different superscripts are significantly different ($p<0.05$)
n.d. corresponds to a non detected compound
[1] On Rtx-5MS column (60m x 0.25 mm i.d., 0.5µm)
[2] RI below 600, the first alkane detected was hexane
[3] Coefficient of variance (n=10)