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Sulphur-containing compounds in butter and their influence on butter aroma

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Introduction

Volatile sulphur (*S*) compounds, with their often occurring low odour thresholds, are known to influence the flavour of a variety of foods and beverages and their presence in a matrix, even in sub-ppb quantities, might cause a significant effect on the sensory properties of that matrix (1, 2) .

Although butter aroma has been widely investigated (3), little is known about the influence of *S*-compounds on its flavour (4, 5). The formation of these compounds in butter might include oxidative, thermal, enzymatic and microbial reactions (5).

Objectives

- **Identification of the most important aroma compounds of four sour cream butter samples, with special focus on *S*-containing compounds.**
- **Recombination of the aroma profile of the four sour cream butters, using the Virtual Aroma Synthesizer (VAS®, Givaudan).**
- **Investigation of the influence of the volatile *S*-compounds on butter aroma, evaluating a butter aroma recombination by quantitative descriptive sensory analysis.**

Experimental

- **The aroma profile of four commercial sour cream butters from Switzerland, France, Germany and Ireland were analysed by GC-MS-O, using HS-SPME (DVB/CAR/PDMS 50/30 µm 2 cm-fibre).**
- **The most volatile *S*-compounds of the four butters were analysed by GC/pulsed flame photometric detection (GC/PFPD), using static headspace extraction.**

Recombination Study

- **The VAS® (6) allowed the combination of the key-aroma compounds of each butter.**

A sweet cream butter, with a very mild aroma, was used as odour matrix. Five panelists compared the odour blowing out of the VAS® with that of the butter sample. The air flow was regulated to obtain a final odour impression as similar as possible to that of the real butter sample. The concentration of each key-aroma compound in the gas-phase was estimated using a special software combined with the VAS®.

- **Quantitative descriptive analysis: a sensory panel (*n*= 12) evaluated the odour and aroma intensities of "diacetyl", "cooked milk", "caramel-nutty" and "green" attributes of three different recombinations of the Swiss butter (table 2): without *S*-compounds (*S*-), with *S*-compounds in the same concentration as found in the butter (*S*+) and with the double concentration of *S*-compounds (*S*++).**

Results

S-compounds in butter by GC-MS-O and GC/PFPD

Table 1 Sulphur-containing compounds of four sour cream butters

S-compounds	LRI DB-5MS	Odour GC-O	Identification[b]	Swiss butter	French butter	German butter	Irish butter
Methanethiol[a]	-	-	GC/PFPD	x	x	x	x
Carbon disulphide[a]	-	-	GC/PFPD	x	x	x	x
Dimethyl sulphide[a]	-	-	GC/PFPD	x	x	x	x
Dimethyl disulphide	785	garlic-like	GC-MS-O GC/PFPD	x	x	x	x
2-Methyl-3-furanthiol	890	meaty, broth-like	GC-MS-O	x	x	x	x
Dimethyl trisulphide	978	cheesy, sulphury	GC-MS-O GC/PFPD	x	x	x	x
Methional	917	potato-like	GC-MS-O	-	-	x	x
Dipropyl disulphide	1122	garlic-like	GC-MS-O	x	-	x	-

[a]S-compounds detected only by GC/PFPD, using SPB-1 Sulfur column; the LRI of these S-compounds were not calculated. [b]All of the compounds were identified using their pure references.

All the butter samples contained *S*-compounds. In particular methional was found only in the German and Irish butter, whereas dipropyl disulphide only in the Swiss and German samples.

Sensory evaluation of the Swiss butter aroma recombination, with three different concentration levels of *S*-compounds

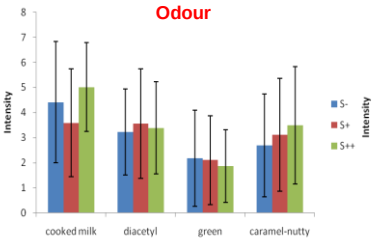

Fig 1 Odour attributes of three Swiss butter aroma recombinations

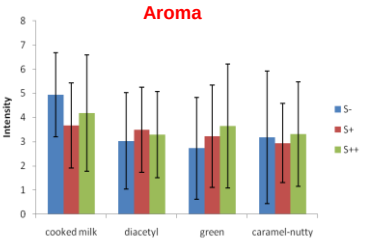

Fig 2 Aroma attributes of three Swiss butter aroma recombinations

Significant differences were found only for the "cooked milk" odour and aroma (p≤0.05). Samples *S*- and *S*++ had a higher cooked milk flavour. Perhaps a different *S*-compounds concentration in *S*+ led to a different aroma interactions, resulting in a weaker "cooked-milk" odour/aroma. "Caramel-nutty" odour and "green" aroma were more intense in the butter recombination containing *S*-compounds and especially in *S*++.

The recombination *S*+ had a slightly higher "diacetyl" odour and aroma.

Aroma recombination of sour cream butters by VAS®

Table 2 Estimation of the concentration of the most important aroma compounds of four sour cream butters calculated in the headspace by VAS®

Compounds[c]	LRI DB-5MS	Odour GC-O	Estimated concentration by VAS® (ppt)			
			Swiss butter	French butter	German butter	Irish butter
Acetic acid	565	vinegar-like	95	334	231	232
Diacetyl	581	buttery	15	52	54	73
Butanoic acid	763	cheesy	1.3	4.7	3.2	3.3
Hexanal	800	green, fatty	-	-	$1.5\ 10^{-2}$	-
3-Methylbutanoic acid	863	cheesy	0.09	0.47	5.47	0.11
(*E*)-2-Hexenol	876	green, hazelnut	0.37	1.30	18	0.60
2-Methyl-3-furanethiol	890	meaty	$2.4\ 10^{-3}$	$1.5\ 10^{-3}$	$3.7\ 10^{-3}$	$1.5\ 10^{-3}$
Methional	917	potato-like	-	-	$2\ 10^{-5}$	$2\ 10^{-5}$
2-Acetylpyrroline	934	popcorn-like	-	606	-	-
Dimethyl trisulfide	978	onion-like	$2\ 10^{-4}$	$4.5\ 10^{-4}$	$4.7\ 10^{-4}$	$4.7\ 10^{-4}$
3,5-Octadien-2-one	1095	mushroom-like	283	-	-	691
Nonanal	1112	fatty	-	-	-	$1.5\ 10^{-2}$
Dipropyl disulfide	1122	garlic-like	$3.2\ 10^{-5}$	-	10^{-5}	-
Ethylfuraneol,	1144	caramel	-	-	0.4	-
4-Ethyl-benzaldehyde	1203	nutty	-	0.8	-	-
δ-Octalactone	1278	coconut-like	0.3	-	-	-
2-Undecanone	1295	fruity	605	-	-	-
Skatole	1385	mothball-like	-	-	0.00047	0.00047
(Z)-6-Dodecen-γ-lactone	1693	fruity	-	0.22	0.12	0.08
δ-Dodecalactone	1714	fruity	0.1	0.5	0.3	-

[c]Key-aroma compounds found in a previous study (data not shown) by GC-O-Aroma Extract Dilution Assay (AEDA) on SAFE (Solvent Assisted Flavour Evaporation)-extracts. FD-factor ≥16. Although δ-decalactone and 2-nonanone were important aroma compounds of the four butters, they were not added in the recombinations because they are already present in the sweet cream butter used as matrix.

Based on GC-O results and VAS® calculation, the aroma of the four butters was reconstituted in Miglyol 812N and then spiked (0.1%) in the sweet cream butter (matrix).

The Swiss butter aroma was characterised by fruity odours (2-undecanone, δ-octalactone), whereas the French butter aroma had distinctive nutty notes (4-ethyl-benzaldehyde, 2-acetyl-pyrroline). The German one was characterised by green (hexanal) and caramel notes (ethyl furaneol). The Irish butter aroma had mainly green (*E*-2-hexenol) and fatty/animal notes (nonanal, skatole).

Conclusion

The VAS® enabled a quick and effective aroma recombination based on the GC-O results of the four sour cream butters, without analytical quantification.

A preliminary sensory evaluation study of a butter aroma recombination indicated that different concentration levels of *S*-compounds had an influence on the final butter flavour.

"Cooked milk" and "caramel-nutty" odour and the "green" aroma were more intense in the recombination with the highest *S*-compounds concentration. Further omission and addition studies with *S*-compounds are necessary to elucidate the interactions of *S*-compounds with the other aroma components and their influence on butter aroma.

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