Influence of the cheese composition on the aroma content, release and perception

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Introduction

The quality of the aroma of cheese is determined by the balance of volatile compounds produced mainly by microorganisms during the transformation of milk into ripened cheese. The nature of the microorganisms constituting the secondary microflora and the technological parameters used for the production of cheeses influence the composition, such as the production of volatile compounds. The perception of these compounds is itself modulated by the composition and the structure of the cheese, through the set of complex interactions between these compounds and the different constituents of the cheese (fat, water, proteins, etc.). The objective of this study is to perform a sensory description of the cheese, and to characterize the influence of the cheese composition on the aroma production, the aroma release and their perception.

Methods

Cheeses

✓ Composition of 16 pressed uncooked raclette-type cheeses produced in the mini experimental cheese-making plant at INRAE URTAL, ripened for 10 weeks at 12°C. Flavour and structure of cheeses were controlled by varying 4 factors at 2 different levels.

Cheese Code	Fat (G, %)	Milk lactose (T, g.l^{-1})	Salt (S, %)	Lactic acid bacteria
G1T1S1A1	40	33	2.5	A1
G1T1S1A2	40	33	2.5	A2
G1T2S1A1	40	42	2.5	A1
G1T2S1A2	40	42	2.5	A2
G1T1S2A1	40	33	4	A1
G1T1S2A2	40	33	4	A2
G1T2S2A1	40	42	4	A1
G1T2S2A2	40	42	4	A2
G2T1S1A1	50	33	2.5	A1
G2T1S1A2	50	33	2.5	A2
G2T2S2A1	50	42	4	A1
G2T2S2A2	50	42	4	A2
G2T2S1A1	50	42	2.5	A1
G2T2S1A2	50	42	2.5	A2
G2T1S2A1	50	33	4	A1
G2T1S2A2	50	33	4	A2

Sensory evaluation

Classical descriptive profile (QDA)

✓ List of the 30 aroma descriptors and the associated scale submitted to 12 trained judges

Descriptor: Weak — Strong

Fresh lactic	Cooked milk	Milky
Acidified milk	Sour milk	Animal
Fruit	Citrus fruit	Jam
Caramel	Toasted	Burnt
Mushroom	Vegetal	Green
Vegetal	Broth	Yeast
Nut	Soap	Tyre
Oxidized	Alcohol	Chemical
Sulphur	Rancid	Rust
Vanilla	Mild roasted	Strong Roasted

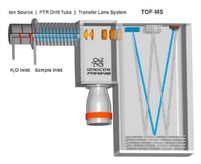
Aroma identification

Gas chromatography-Mass spectrometry

✓ Headspace analysis of cheese (1 g) with SPME CAR/PDMS fiber; equilibrium at 40°C during 30 min then contact with fiber during 40 min
✓ GC-MS Agilent 6890/5977; EI 70eV; column RTX5; He 2 mL/min; injector 250°C; oven from 40 to 250°C

Aroma release

PTR-ToF-MS Analyses



✓ Nosespace analyses coupled to a Proton Transfer Reaction-Time of Flight-Mass Spectrometer (PTR-ToF-MS 8000 with ion funnel, Ionicon Analytik GmbH, Innsbruck, Austria)
✓ Drift-tube parameters: T 80°C; U 390 V; p 2.3 mbar; E/N 92 Td
✓ Areas under the curves during the cheese consumption

Dynamic sensory evaluation

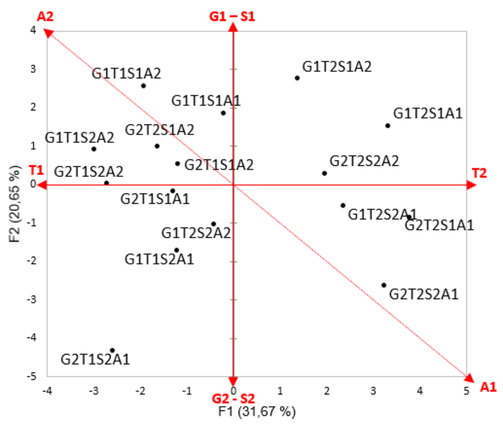
✓ 12 judges
✓ Cheese: one piece of 7.0 ± 0.2 g
✓ Temporal Check-All-That-Apply (TCATA)

☐ Animal ☐ Mild roasted ☐ Salty ☐ Vegetable ☐ Spicy ☐ Acid ☐ Fruity ☐ Milky ☐ Rancid, soap, sour ☐ Bitter

Results

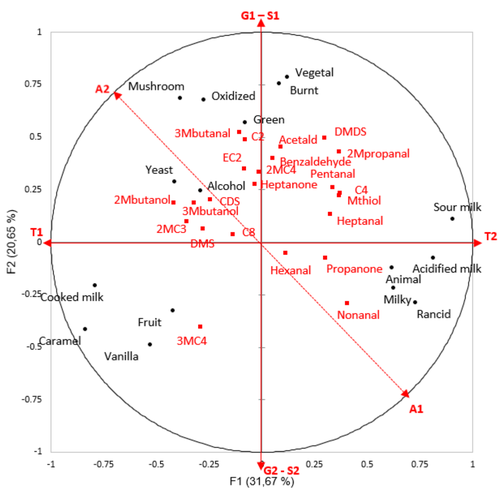
Sensory evaluation and aroma identification

✓ 30 sensory descriptors evaluated
✓ 36 aroma compounds identified and semi-quantified by GC-MS



The PCA on Figure 1a shows a different repartition of the 16 cheeses according to the 4 factors, *ie* fat (G), lactose (T), salt content (S) and nature of strains (A).

Figure 1a: Individual map (1-2) of the PCA of the 16 cheeses on both QDA and GC-MS data



The production of flavour compounds was favoured by these conditions:

- High content of milk lactose (sulfur compounds, aldehydes)
- Low content of fat (aldehydes)
- Stain A2 (amino-acid, derived compounds)
- Little effect of salt

M: methyl, D: di, S: sulfide,
C2, C3, C4, C6, C8: acetic, propionic, butyric, hexanoic, octanoic acids
EC2: ethyl acetate

Figure 1b: PCA correlation circle of the 16 cheeses on sensory descriptors (main variables in black) and aroma compounds (additional variables in red)

16 aroma descriptors differentiated the factors after ANOVA (not shown), and were represented Figure 1b.
The most influent factors were milk lactose content and fat level (9 and 7 descriptors affected), then strain and salt (5 and 4 descriptors). Lactose level discriminated sweet and sweaty notes, low fat and salt levels showed green and oxidized notes. Strains opposed green and fermented from rancid notes.

Aroma release: PTR-ToF-MS analyses

✓ 17 aroma compounds followed and identified with PTR-MS

Experimental mass (m/z)	Chemical Formula	Expected mass (m/z)	Identification
43.055	$C_3H_7^+$	43.055	Alkyl fragment
45.033	$C_2H_5O^+$	45.033	Acetaldehyde
47.049	$C_2H_6OH^+$	47.049	Ethanol
49.010	CH_5S^+	49.011	Methanethiol
63.027	$C_2H_7S^+$	63.026	Dimethyldisulfide
63.039	$C_2H_7O_2^+$	63.044	Acetaldehyde-water cluster
65.023	$C_5H_5^+$	65.038	Fragment
65.061	$C_2H_9O_2^+$	65.060	Ethanol-water cluster
71.085	$C_5H_{11}^+$	71.086	Fragment (terpene, ester)
81.069	$C_6H_9^+$	81.070	Terpene fragment
87.044	$C_4H_7O_2^+$	87.044	2,3-butanedione
87.080	$C_5H_{11}O^+$	87.080	3-methylbutanal, 2-methylbutanal
87.096	$C_4H_{11}N_2^+$	87.092	Piperazine
89.057	$C_4H_9O_2^+$	89.060	3-hydroxybutan-2-one
89.077	$C_5H_{13}O^+$	89.096	3-methylbutan-1-ol, 2-methylbutan-1-ol
91.019	$C_3H_7OS^+$	91.021	Methylthioacetate
93.071	$C_7H_9^+$	93.069	Toluene, terpene fragment
101.097	$C_6H_{13}O^+$	101.096	Hexanal
115.111	$C_7H_{15}O^+$	115.112	Heptanal
115.143	$C_8H_{19}^+$	115.148	Octane
117.091	$C_6H_{13}O_2^+$	117.091	Hexanoic acid
117.117	$C_7H_{17}O+$	117.127	Heptan-2-ol, heptan-1-ol
137.132	$C_{10}H_{17}^+$	137.132	Terpene

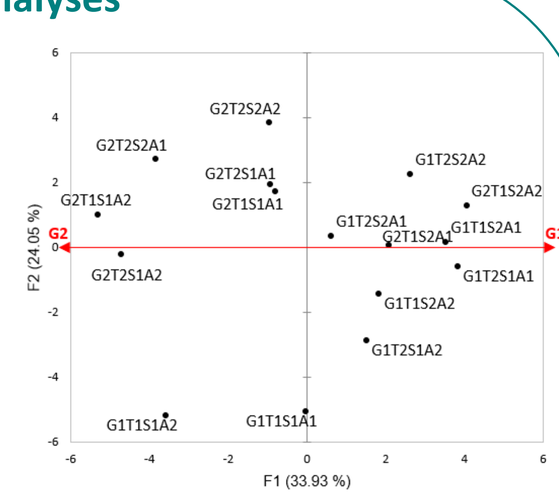


Figure 2: Individual map (1-2) of the PCA of the 16 cheeses

As expected, interindividual variations were observed between subjects for both temporal perception and temporal flavour release (data not shown).
The first axis of PCA (Figure 2) seems to separate the fat levels (G1 and G2): a high level of fat seems to be correlated to a high release of most flavour compounds.
The G1T1S1A1 and G1T1S1A2 products seem to differ from the other cheeses by the expression of ions 81.069 and 137.112, from terpenes, and the ions 63.027 (dimethyldisulfide), 63.050 (unknown), 65.023 (fragment) (Figure 3).

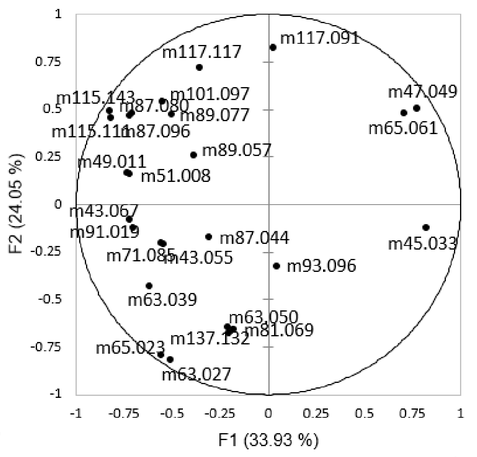


Figure 3: Variables PCA of aroma compounds (m/z)

Aroma release: dynamic sensory evaluation

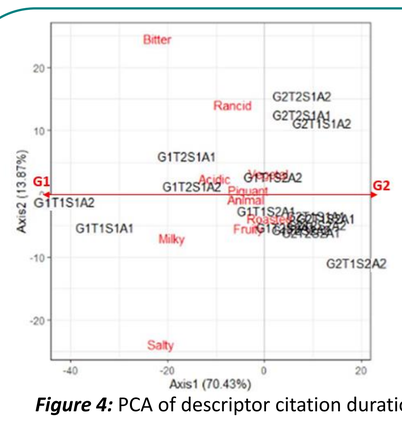


Figure 4: PCA of descriptor citation duration

Milky and salty descriptors were essentially present at the start of consumption (data not shown).
Figure 4 shows the descriptor duration for the TCATA analyses.
The first axis of PCA separated the fat levels. A low level of fat seems to be correlated to Bitter, Milky and Salty. These 3 descriptors discriminated the products after ANOVA.
Interactions between the different cheese composition parameters may explain the observed variations in perception.

Conclusion

The cheese fat and salt levels, the milk lactose level and the nature of lactic acid bacteria strains differently influenced the sensory perception, the aroma release and the composition in aroma compounds. These results could be used to better control the development of new dairy products.

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