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Identification of odour active compounds generated in a processed cheese-like model system

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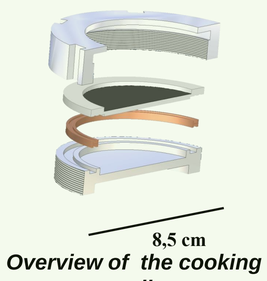
➢ Context

The elaboration of food and especially their thermal treatment lead to major changes in food rheology, colour, nutritional value, microbiological stability and flavour properties. In the case of processed cheese, the first four points are relatively well known and taken into account for its production. However there is still a need to integrate the developpement of flavour in the multi-objectives optimisation strategies. This work aims at the identification of odour-active compounds which are influenced by the heating conditions.

➢ Material and Methods

Processed Cheese-like model formulation: Native Caseinate, skimmed milk powder, citric acid, emulsifying salts and natrium chloride were hydrated overnight in water at 4°C. Anhydrous milk fat was emulsified at 25°C for 10 min using a Janke and Kunkel T25 Ultra-Turrax (20500 rpm). The Cheese matrix was then stored at 4°C and cooked during its day of fabrication.

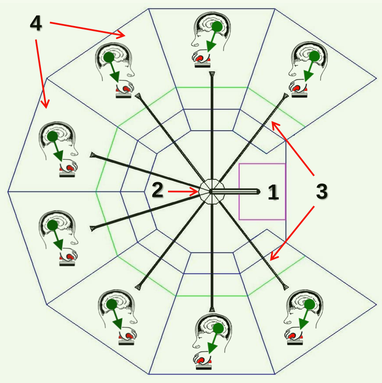
Cooking process: a 10 g sample was cooked in an hermetically closed cooking cell designed to heat uniformly as quickly as possible the cheese matrix without any volatile compound leak. This cell is subjected to a succession of thermal treatments such as boiling water and/or superheated steam. Details concerning the pilot plant can be found in [1].



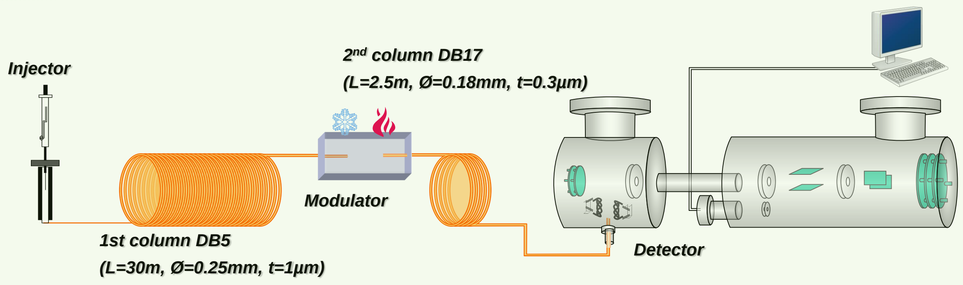
Overview of the cooking cell

GCxGC-Mstof analyses: A SPME Carboxen/PDMS, 75 µm fiber was equilibrated with the headspace of an 1g sample for 30 min at 30°C. A "LECO Pegasus IV" GC x GC-MS*tof* instrument (LECO Corporation, St. Joseph, MI, USA) was used to identify the volatiles compounds.

Identification of odour active compounds: An eight-way gas chromatograph-olfactometer (GC-MS-8WO) allows to detect a maximum of odorants. It consists of a chromatograph coupled to a divider that distributes the volatile component outflow evenly and synchronously to eight sniffing ports located in separated booths. The GC-MS-8WO analytical conditions are described in detail in [2]. An independent GC-O-MS device was used to phase olfactory and mass spectrometry signals in order to propose structures for odour-active compounds.



Overview of GC-MS-8WO system
1: GC-MS; 2: Divider; 3: 8 transfer lines; 4: 8 booths

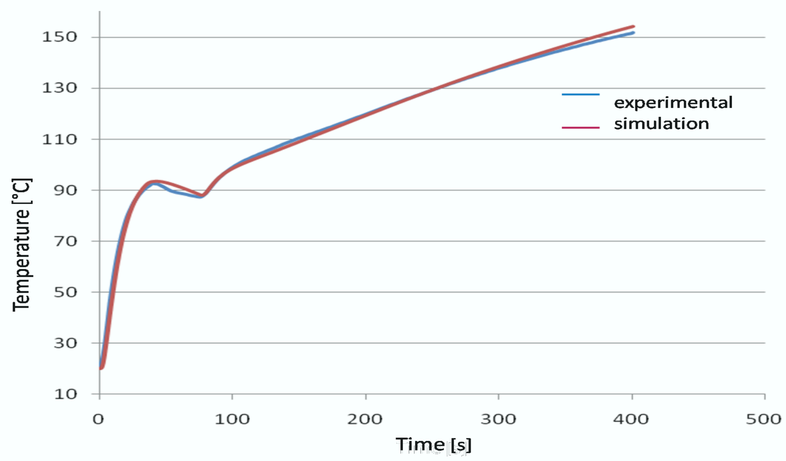


Comprehensive gas chromatography – time-of-flight mass spectrometry (GCxGC-MStof)

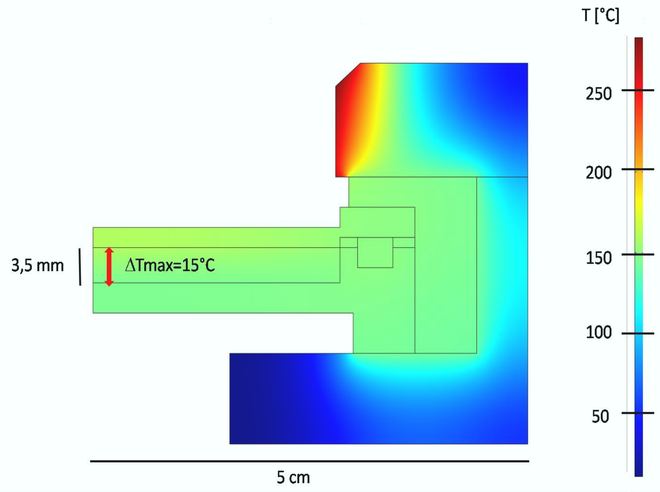
➢ Results

Evaluation of the thermal treatment :

Comparison between experimental and simulated temperature profile at the center of the cheese matrix



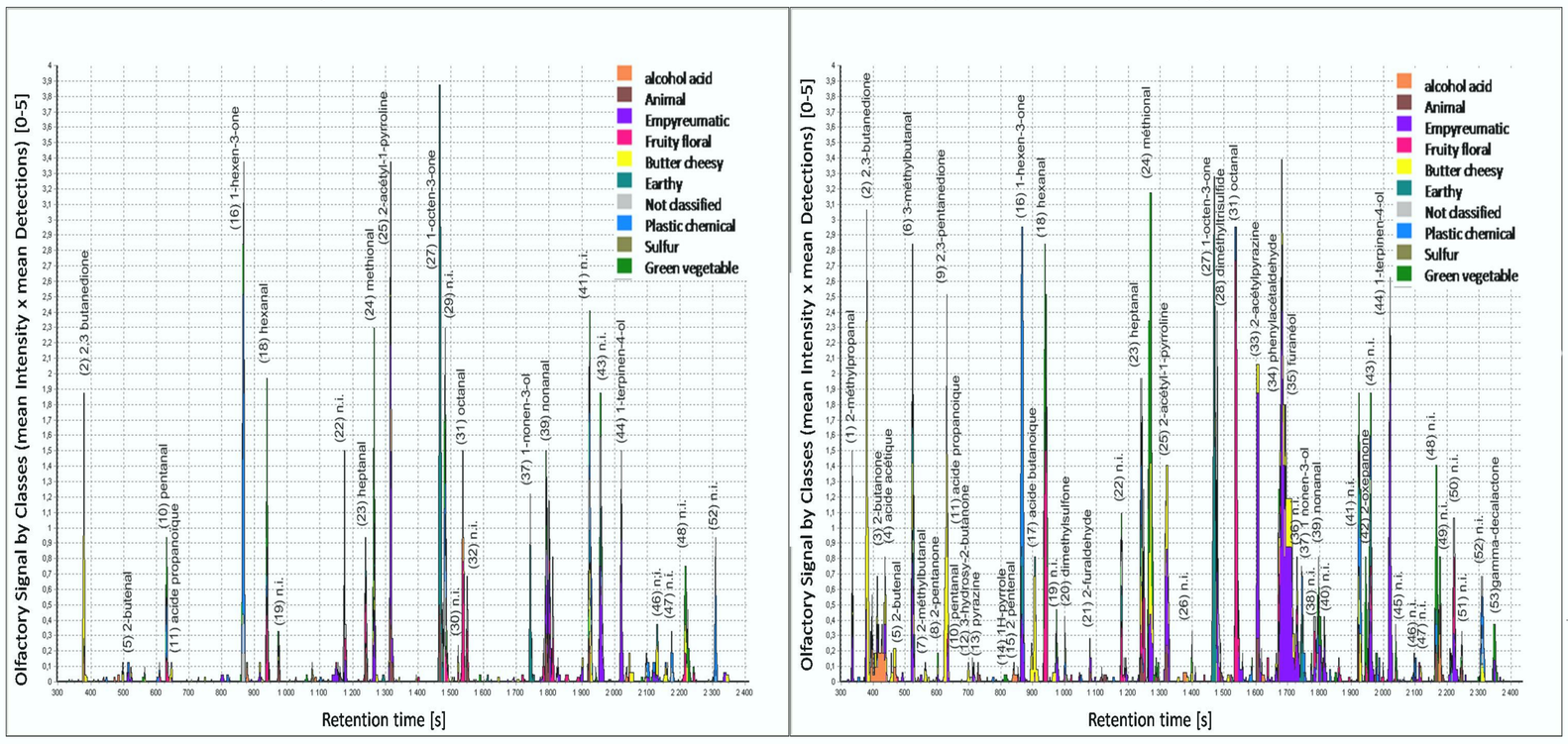
Overview of the Temperature profile inside the processed cheese sample at the end of the treatment



Both experimental measurements and numerical simulations demonstrate a good temperature reproductibility at the end of the treatment (less than +/- 5°C)

Evaluation of odour active compounds:

Aromagrams obtained with the 8W-GCO device for the raw sample (left) and the heated one (right)



Odour active compounds detected by GC-O and identified by GCxGC-MStof

Peak number	Olfaction Retention time [s]	LRI	Chemical name	Reliability of ID	Descriptors	t-test
1	**330**	**552**	**propanal,2-methyl-**	**A**	***Empyreumatic***	**
2	385	581	2,3-butanedione	A	*Butter*	+
3	410	594	2-butanone	A	*Lactic, Yoghourt*	+
4	**410**	**594**	**acetic acid**	**A**	***Vinegar***	*
5	**500**	**637**	**2-butenal**	**A**	***Cheesy***	*
6	**524**	**648**	**butanal,3-methyl-**	**A**	***Chocolate, Rancid, Cheese***	***
7	**545**	**657**	**butanal,2-methyl**	**A**	***Empyreumatic***	***
8	602	681	2-pentanone	A	*Milk*	
9	**620**	**689**	**2,3-pentanedione**	**A**	***Butter, Yoghourt***	**
10	629	693	pentanal	A	*Grass, Orange*	
11	641	695	propanoic acid	A	*Cheese*	
12	676	712	3-hydroxy,2-butanone	A	*Cheese*	
13	729	732	pyrazine	A	*Coffee, Fish*	
14	798	760	1(H)-pyrrole	A	*Peanut*	
15	853	777	2-pentenal	B	*Floral*	
16	861	780	1-hex-en-3-one	B	*Plastic, Chemical*	
17	895	786	butanoic acid	A	*Cheese, Vomit*	+
18	**933**	**804**	**hexanal**	**A**	***Green apple, Grass***	***
19	970	817	n.i.	-	*Sulfur*	
20	1001	827	dimethylsulfoxide	B	*Sulfur*	+
21	1047	842	2-furaldehyde	A	*Empyreumatic*	
22	1074	851	n.i.	-	*Animal, Ham*	
23	1249	902	heptanal	A	*Citrus, Fruity*	*
24	**1260**	**910**	**methional**	**A**	***Potatoes***	***
25	1309	926	2-acetyl-1-pyrroline	B	*Empyreumatic*	*
26	1396	950	n.i.	-	*Sulfur*	
27	1469	980	1-octen-3-one	A	*Mushroom*	
28	**1472**	**981**	**dimethyltrisulfide**	**B**	***Sulfur, Gas, Cabbage***	*
29	1479	984	n.i.	-	*Bread, Crust*	
30	1522	999	n.i.	-	*Citrus*	
31	1531	1003	octanal	A	*Citrus, Orange,*	+
32	1548	1009	n.i.	-	*Animal*	+
33	1596	1038	2-acetylpyrazine	C	*Empyreumatic*	
34	**1668**	**1055**	**phenylacetaldehyde**	**B**	***Floral***	**
35	**1673**	**1057**	**furanéol**	**B**	***Toffy, Empyreumatic***	***
36	1726	1070	n.i.	-	*Banana*	
37	1745	1077	1-nonen-3-ol	A	*Mushroom*	
38	1770	1098	tetramethylpyrazine	C	*Peanuts*	
39	1790	1107	nonanal	A	*Cut Grass, Leather*	
40	1814	1117	n.i.	B	*Bread, Crust*	
41	1919	1169	n.i.	-	*Chemical*	
42	1940	1179	2-oxepanone	D	*Vegetal*	+
43	1952	1185	n.i.	-	*Plastic, Chemical*	
44	2013	1218	1-terpinen-4-ol	D	*Dry ham, Empyreumatic*	
45	2039	1233	n.i.	-	*Menthol*	
46	2097	1267	n.i.	-	*Plastic, Chemical*	
47	2119		n.i.	-	*Cheese*	
48	2156		n.i.	-	*Vegetal*	
49	2159		n.i.	-	*Plastic, Chemical*	
50	2166		n.i.	-	*Menthol*	
51	2242		n.i.	-	*Animal*	
52	2305		n.i.	-	*Plastic, Chemical*	
53	2340	1450	γ-decalactone	D	*Potatoes, Bedbug*	

n.i. not identified
A mass spectrum, retention index and odour identical with those of an authentic sample
B mass spectrum, retention index and odour in agreement with literature data
C tentative identification by mass spectra
D odour and retention index in agreement with literature data, no mass spectrum found

➢ Conclusion and prospects

Cooking and analytical strategies enabled to get samples with very different odour active profiles. In order to understand the thermal effect on the odour active fraction, these compounds as well as other non odorant key intermediates will now be kinetically measured during various time and temperature treatments.

(1)Kondjoyan, A. and Portanguen, S. (2008). Prediction of surface and "under surface" temperatures on poultry muscles and poultry skins subjected to jets of superheated steam. *Food Research International*, 41(1):16–30.
(2) Berdagué, J.L.; Tournayre, P.; Cambou, S. 2007.Novel multi-gas chromatography-olfactometry device and software for the identification of odour-active compounds. Journal of Chromatography A, 1146 (1), 85-92