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

Emmanuel Bertrand^{1,2*}, Cyril Chevarin¹, Stéphane Portanguen¹, Pascal Tournayre¹, Saïd Abouelkaram¹, Jean-Louis Berdagué¹, Alain Kondjoyan¹ and Anne-Sophie Guillard²

¹ Institut National de la Recherche Agronomique (INRA), Unité de Recherche sur la Qualité des Produits Animaux (UR 370), F - 63122 Saint Genès Champanelle, France; ² Fromageries Bel D.R.A.G., 7 Bd de l'Industrie, F - 41100 Vendôme cedex, France; *email: emmanuel.bertrand@clermont.inra.fr

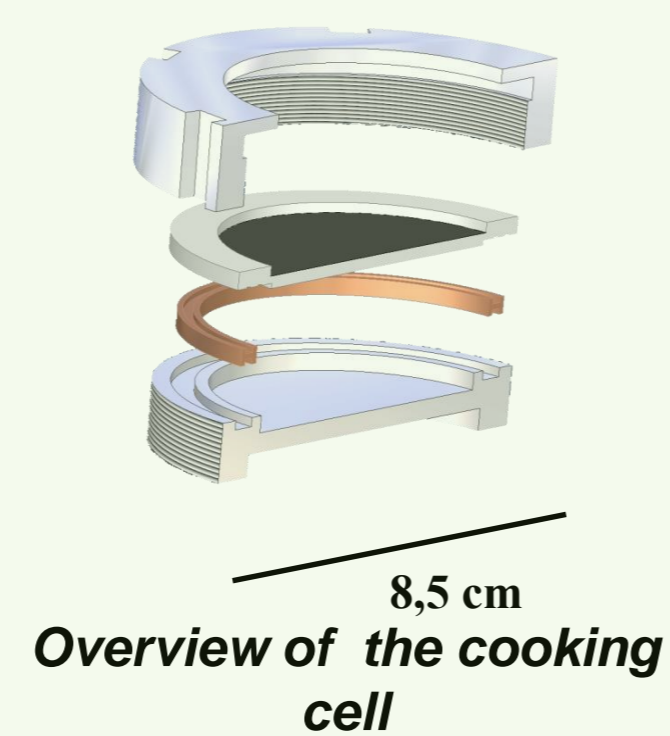
Context

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 development 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 sodium 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.

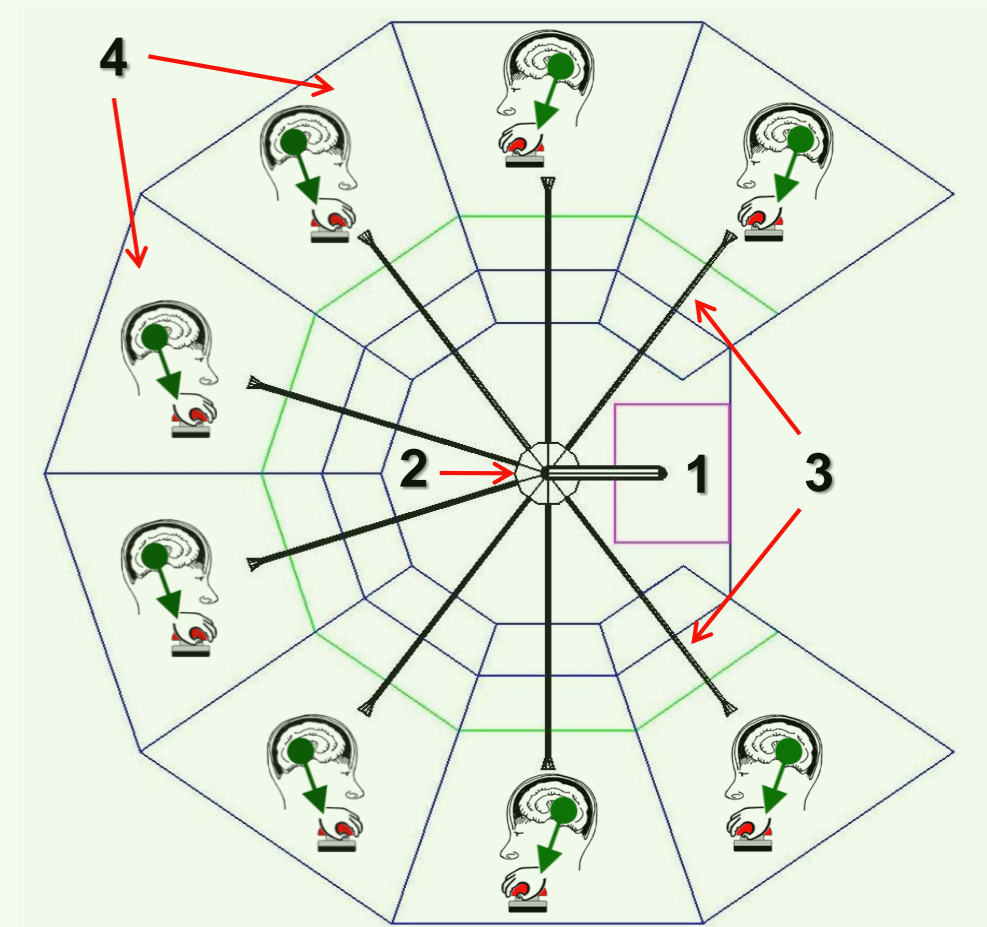
Cooking process: a 10 g sample was cooked in an hermetically closed cooking cell designed to heat uniformly as quickly as possible the cheese matrix without any volatile compound leak. This cell is subjected to a succession of thermal treatments such as boiling water and/or superheated steam. Details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



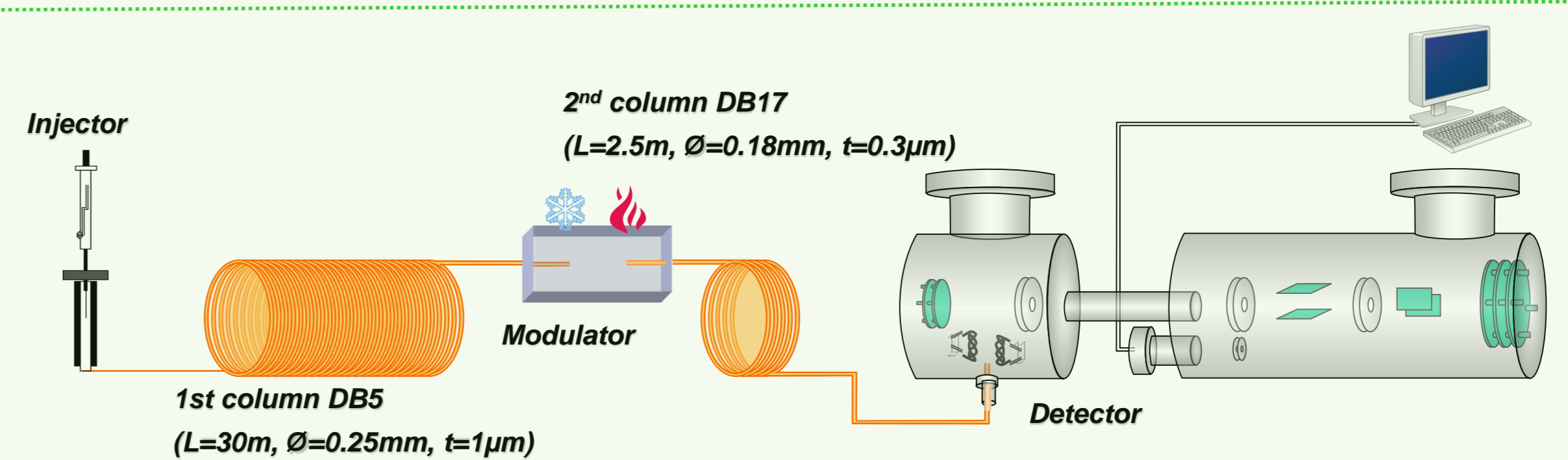
Overview of the cooking cell

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-Mstof 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

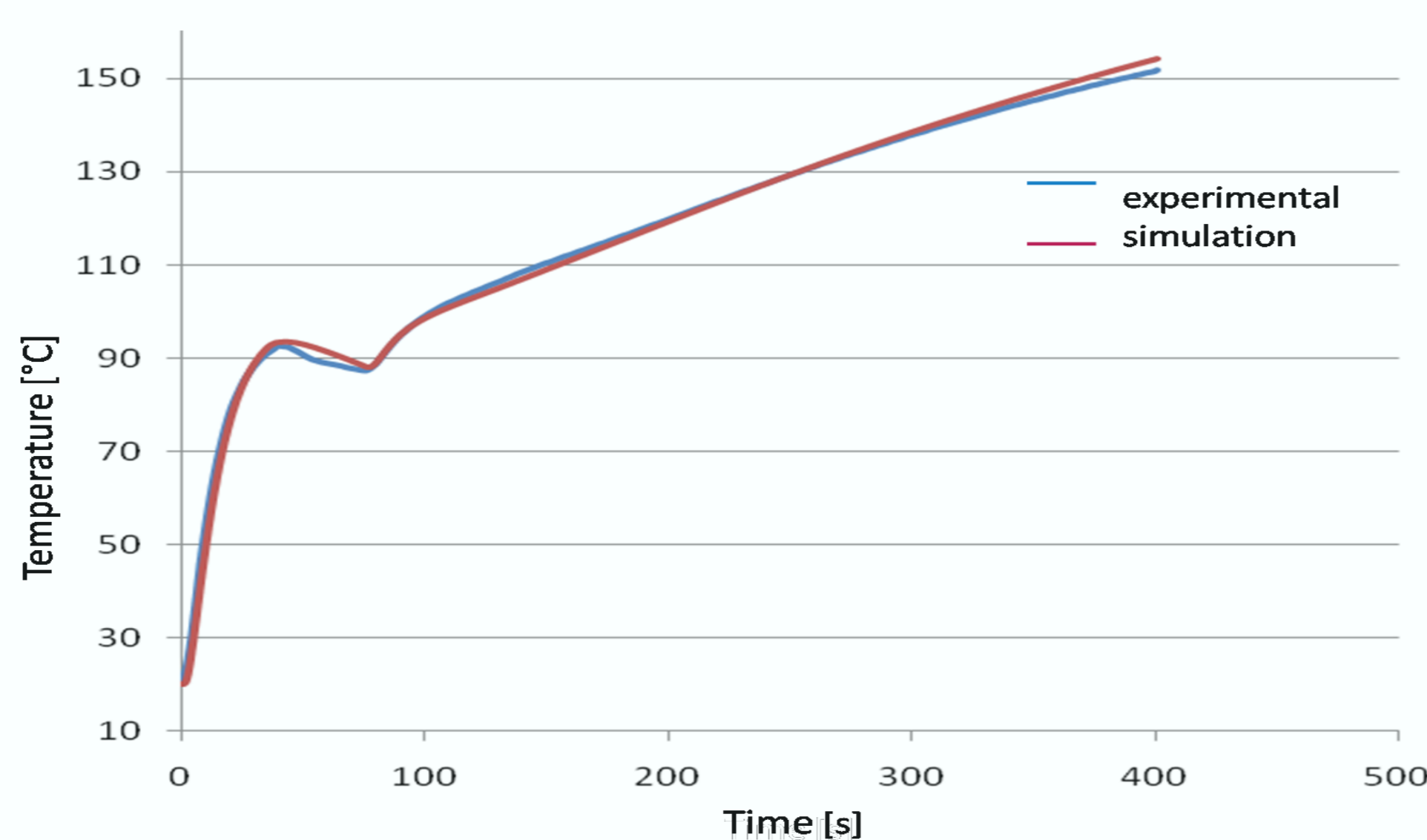


Comprehensive gas chromatography - time-of-flight mass spectrometry (GCxGC-Mstof)

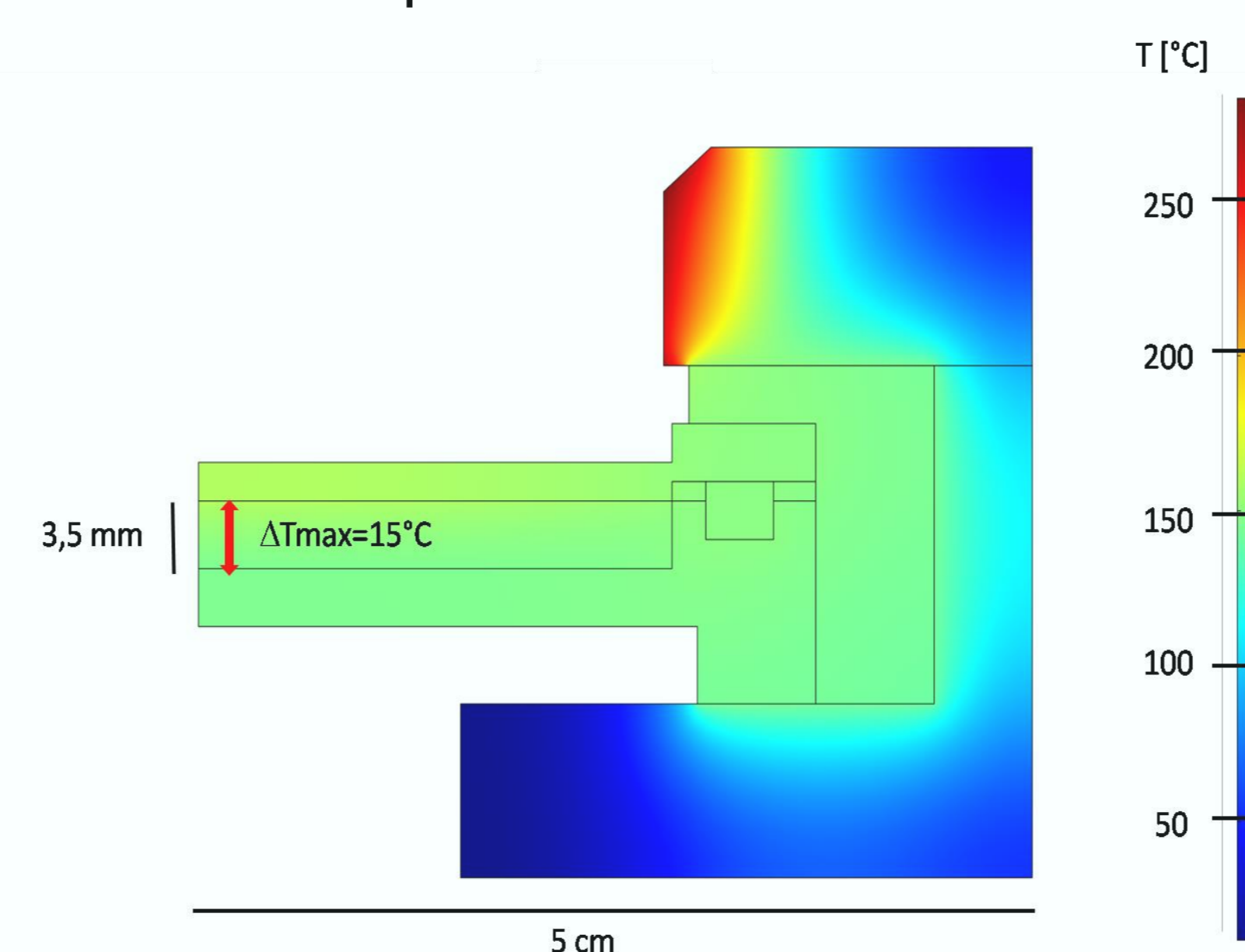
Results

Evaluation of the thermal treatment :

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



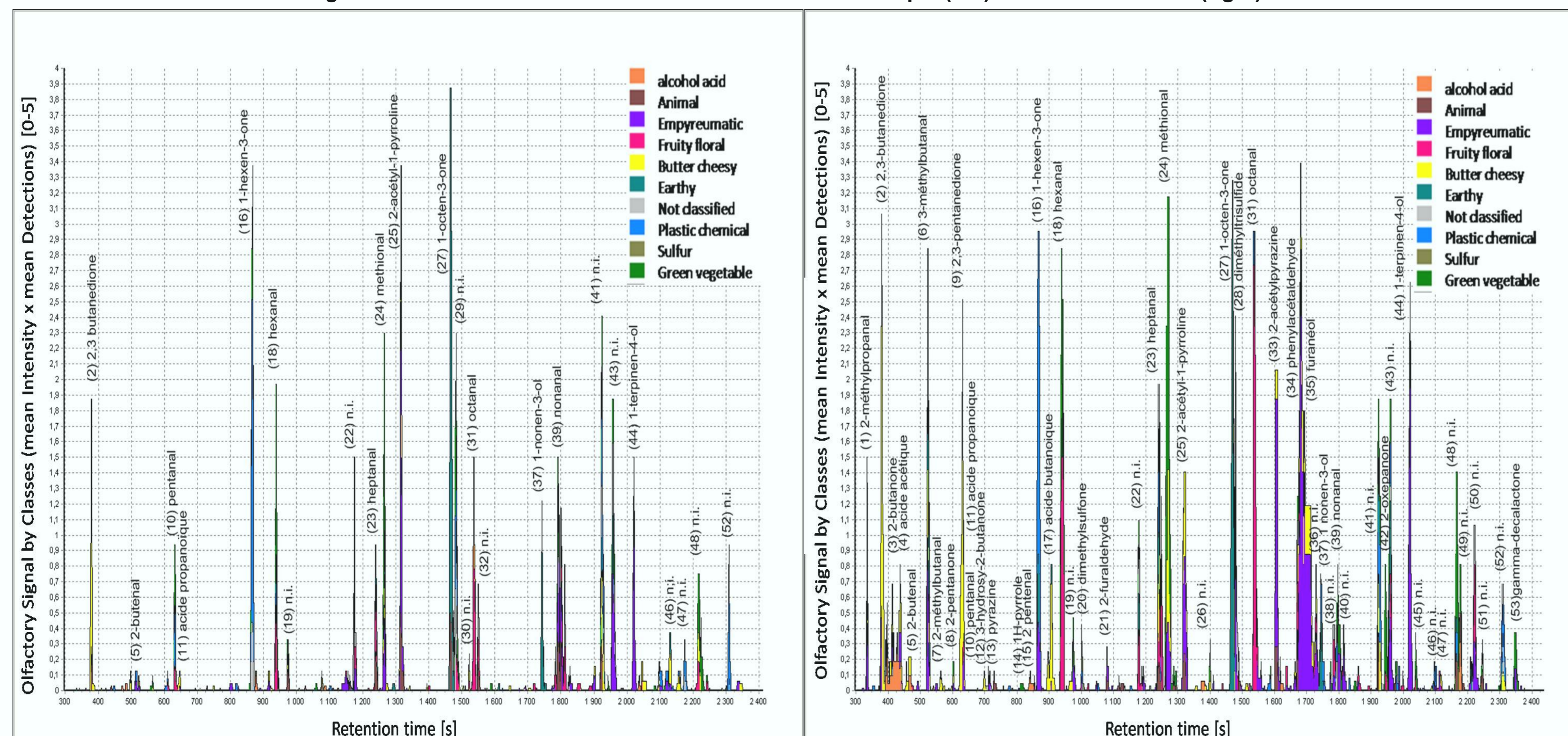
Overview of the Temperature profile inside the processed cheese sample at the end of the treatment



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 ID	Descriptors	t-test
1	330	552	propanal,2-methyl-	A	Emphyreumatic	**
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	Emphyreumatic	***
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-pentanal	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	Emphyreumatic	
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	Emphyreumatic	*
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	Emphyreumatic	
34	1668	1055	phenylacetaldehyde	B	Floral	**
35	1673	1057	furanol	B	Toffy, Emphyreumatic	***
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, Emphyreumatic	
45	2039	1233	n.i.	-	Menthol	
46	2097	1267	n.i.	-	Plastic, Chemical	
47	2119	n.i.	n.i.	-	Cheese	
48	2156	n.i.	n.i.	-	Vegetal	
49	2159	n.i.	n.i.	-	Plastic, Chemical	
50	2166	n.i.	n.i.	-	Menthol	
51	2242	n.i.	n.i.	-	Animal	
52	2305	n.i.	n.i.	-	Plastic, Chemical	
53	2340	1450	γ-decalactone	D	Potatoes, Bedbug	

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

