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E. Bertrand, C Chevarin, S Portanguen, P Tournayre, Saïd Abou El Karam, et al.. Identification of odour active compounds generated in a processed cheese-like model system. EuroFoodChem XVth, Jul 2018, Copenhagen, Denmark. hal-01852762

HAL Id: hal-01852762

<https://amu.hal.science/hal-01852762v1>

Submitted on 2 Aug 2018

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

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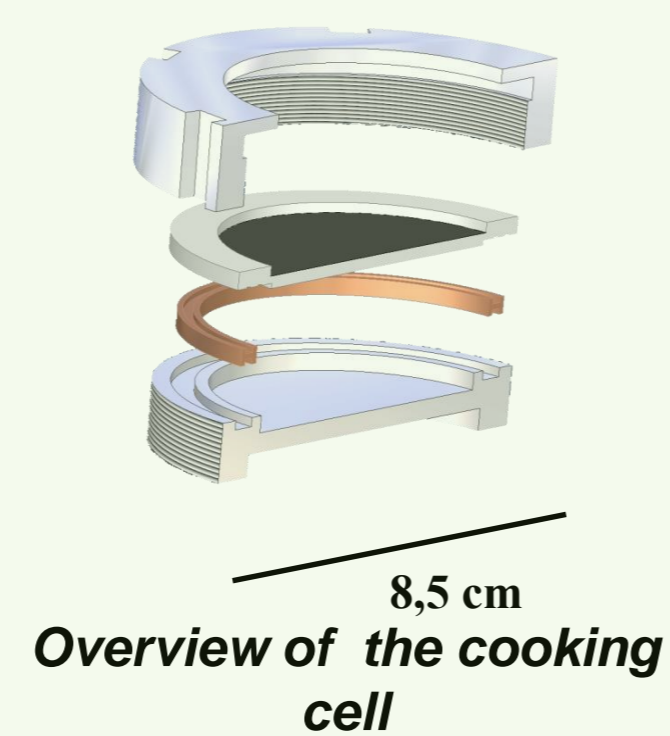
Context

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 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.

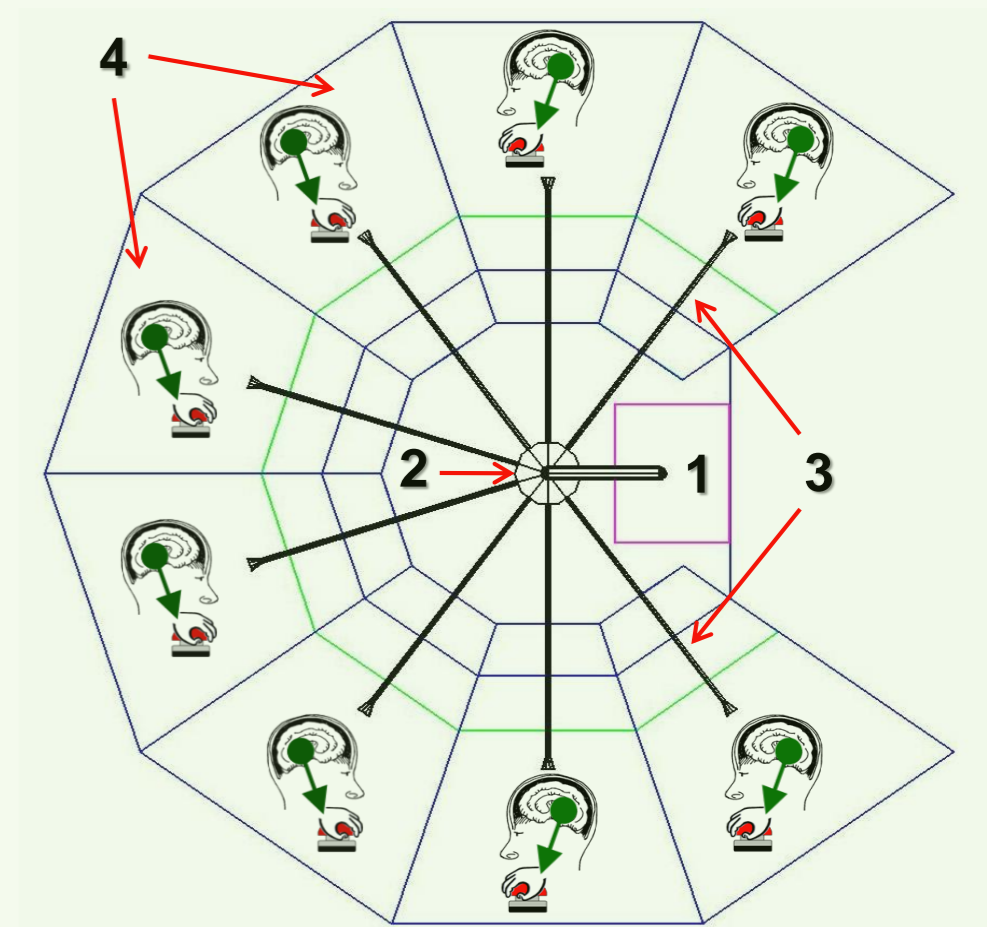
Material and Methods

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].

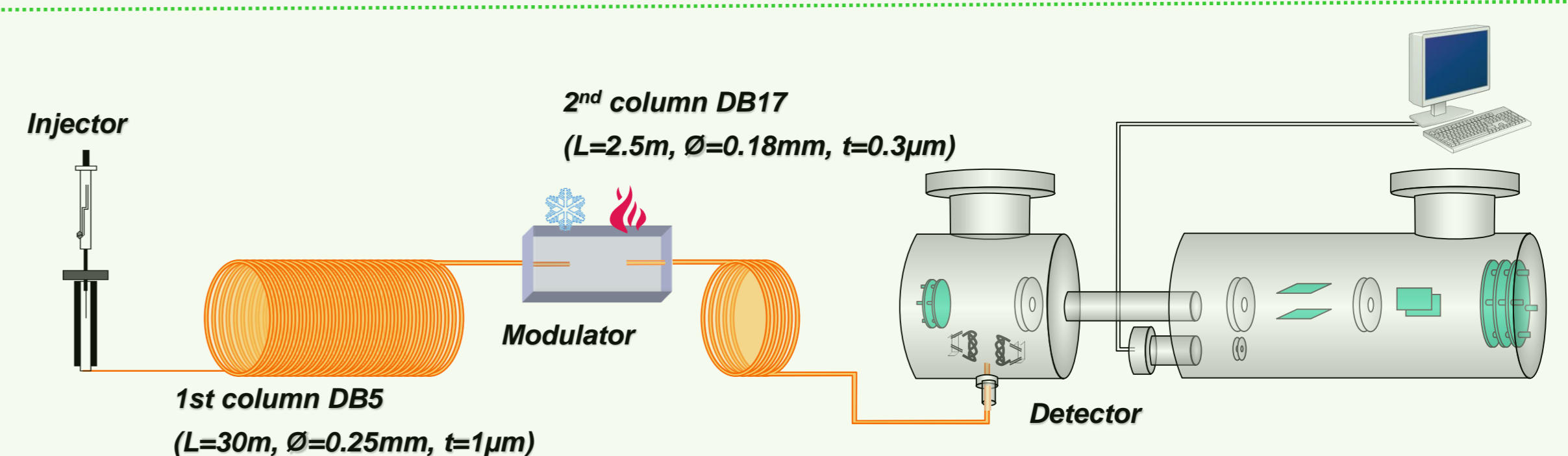


Identification of odour active compounds: An eight-way gas chromatograph-olfactometer (GC-MS-8WO) allows to detect a maximum of odorants. It consists of a chromatograph coupled to a divider that distributes the volatile component outflow evenly and synchronously to eight sniffing ports located in separated 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

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.

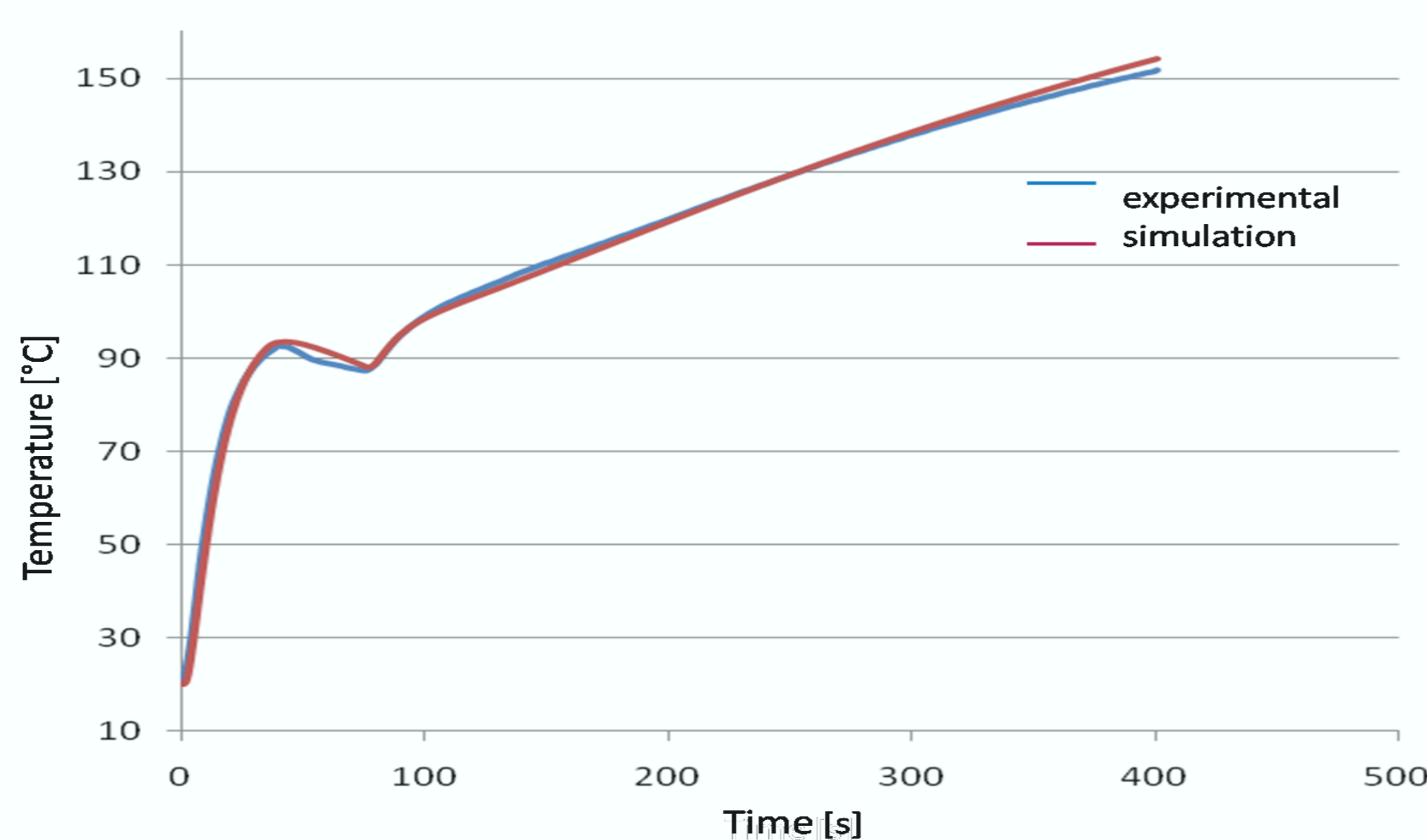


Comprehensive gas chromatography – time-of-flight mass spectrometry (GCxGC-Mstof)

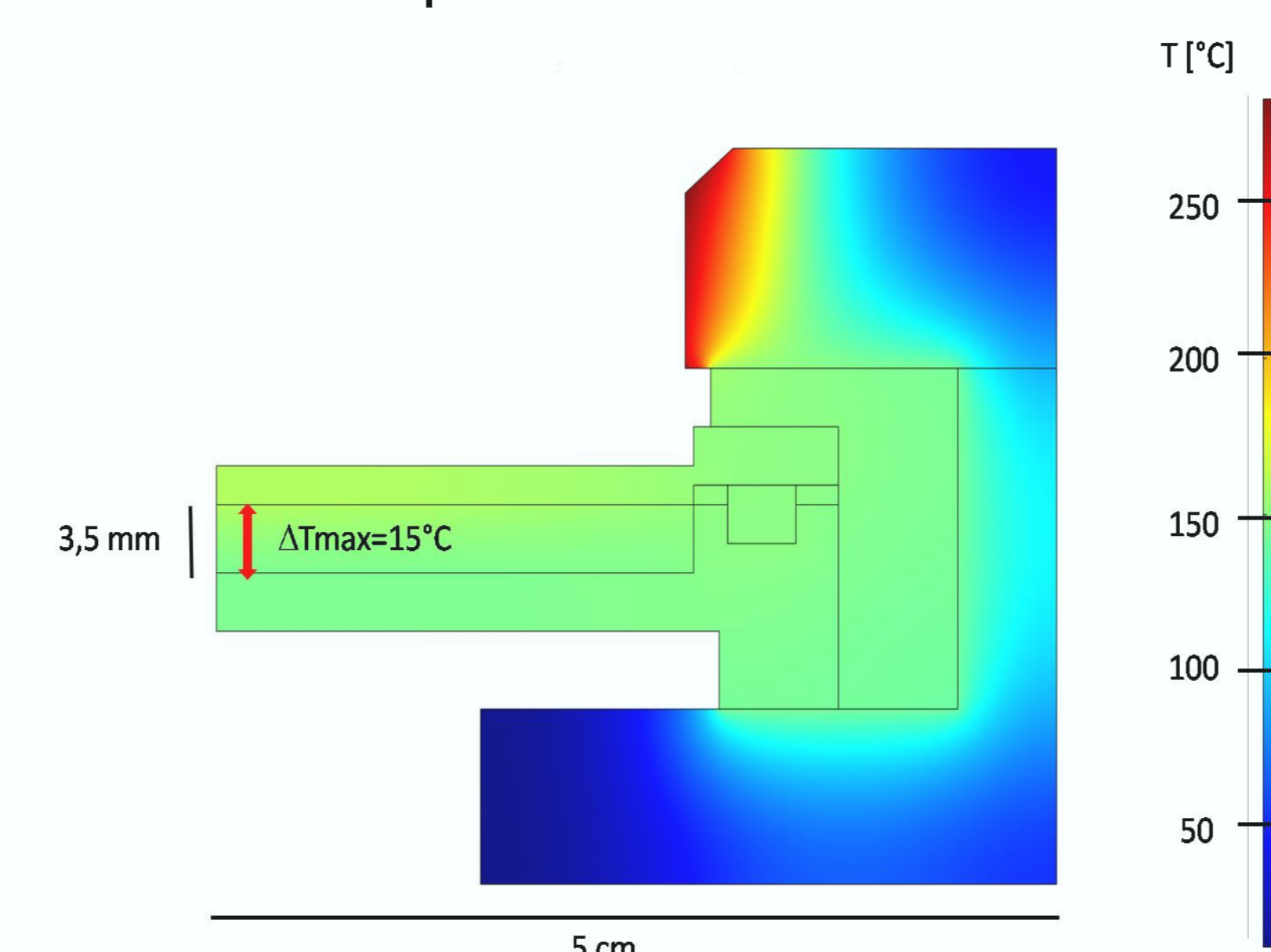
Results

Evaluation of the thermal treatment :

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



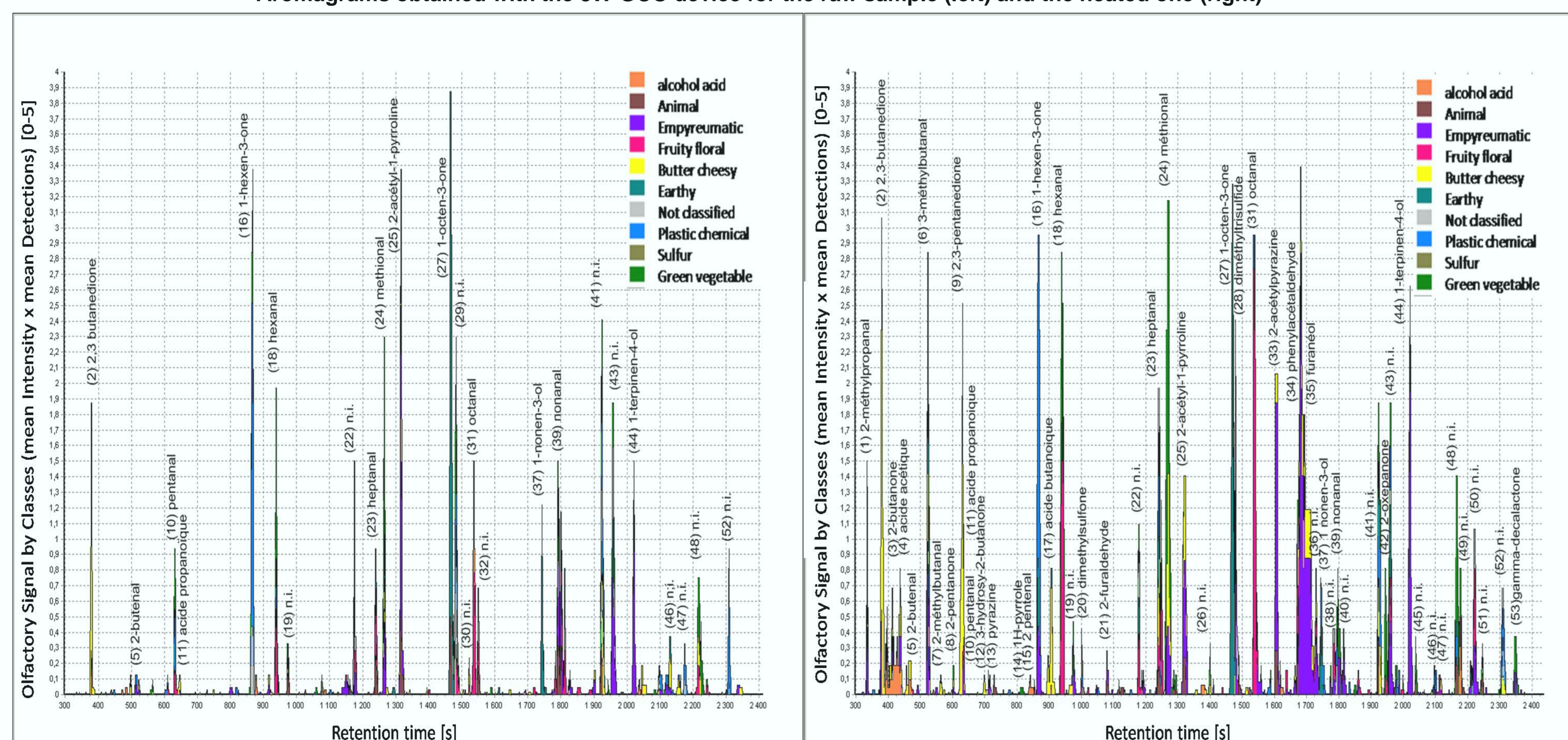
Overview of the Temperature profile inside the processed cheese sample at the end of the treatment



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 | 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

