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Analytical mapping of Swiss Gruyère Cheese to highlight the distribution of aroma compounds using HS-ITEX-GC-MS/PFPD

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Introduction

The evolution of aroma compounds in cheese depends on numerous factors such as the intrinsic raw milk flora, the bacterial cultures used for its manufacture, ripening conditions, and the texture of the cheese. In addition, it is well known that the distribution of aroma compounds in cheese is not homogeneous.[1-5]

In order to highlight the distribution of aroma compounds in a large-scale food matrix as an entire cheese loaf, we studied 39 selected volatile aroma active compounds classified into eight chemical families (carboxylic acids, alcohols, aldehydes, ketones, esters, lactones, pyrazines and sulphur compounds) in a commercial Swiss Gruyère cheese loaf made from raw milk.

Objectives

- **Aroma mapping of the distribution of target volatile compounds** in a Swiss Gruyère cheese by headspace – in-tube extraction and gas chromatography coupled with mass spectrometer/pulsed flame photometric detector (HS-ITEX-GC-MS/PFPD) (fig.2).
- **Sensory analysis of selected samples** to determine the aroma impact of the inhomogeneous distribution of volatile compounds in cheese (fig.3).

Experimental

Commercial Swiss Gruyère cheese AOP (appellation d'origine protégée) was analyzed.

Sample preparation

- One half of a 32 kg cheese loaf was cut into 290 samples of approximately 50 g each along 3 axes (x, y, z), 10 g were grated and homogenized for the analytical analyses and 40 g were reserved for the sensory analyses. The samples were distributed over 5 layers, rind and smear included: Outer zone 1 (10 mm), middle zone 1 (25 mm), central zone (30 mm), middle zone 2 (25 mm) and outer zone 2 (10mm) (fig. 1).

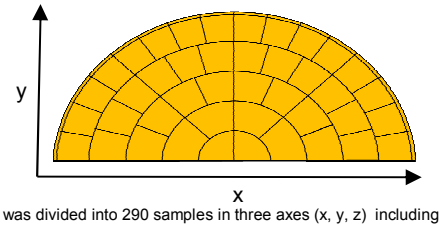
HS-ITEX-GC-MS/PFPD

- HS-ITEX: T= 45 °C; $t_{extraction}$= 30 min (120 strokes), microtrap: Tenax® TA 80/100 mesh

Sensory analysis

- 30 samples covering the three internal layers, middle zone 1, central zone and middle zone 2 (fig.1) of the half-cheese analyzed were judged by 8 trained panellists.
- The check-all-that-apply (CATA) method was applied using a list of 10 selected descriptors: buttery, rancid, herbal, hay, nutty, fruity, animalic, alliaceous, wax and milky. Results are shown as relative frequencies (fig.3).

Analytical and sensory results



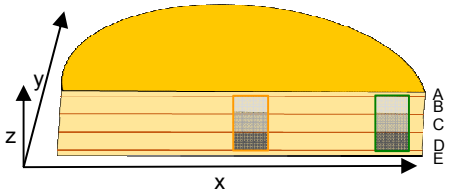


Fig. 1 Sample preparation of a half loaf of cheese. The cheese was divided into 290 samples in three axes (x, y, z) including five layers : outer zone 1 (A), middle zone 1 (B), central zone (C), middle zone 2 (D), outer zone 2 (E).

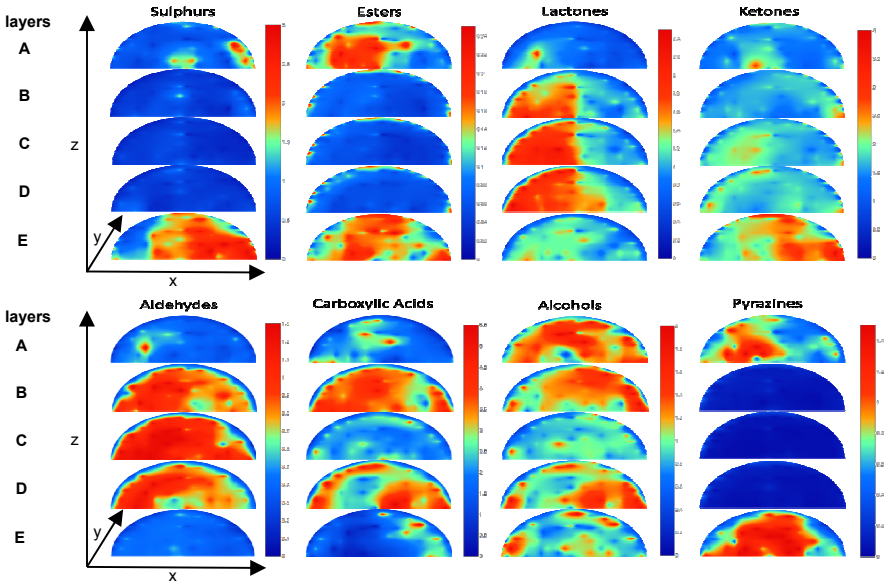


Fig. 2 Aroma mapping of eight selected chemical families. A to E represent the five layers cut in the half cheese loaf. The colour variations, **blue** for **low concentration** and **red** for **high concentration**, correspond to the mass spectrometer normalized signal (total ion count) of the target molecules according to the legends on the right of each plots.

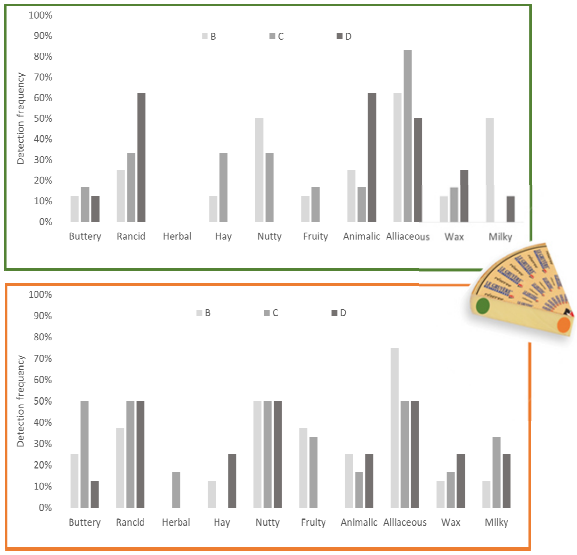


Fig. 3 Check-all-that-apply (CATA) method of two selected zones (**orange** and **green**) on the three internal layers B,C and D. The graphs represents the relative detection frequency in % as function of 10 selected sensory attributes.

Conclusion

A distinct inhomogeneous distribution of aroma compounds was found within the Gruyère cheese loaf. The associated variation in aroma perception was confirmed by the sensory tests. The sulphur compounds, esters and pyrazines are more abundant in the cheese rind and migrate only a few centimetre in direction of the centre. In contrast, the concentration of carboxylic compounds, lactones, aldehydes, ketones and alcohols is higher in the centre of the cheese loaf. It is assumed that the observed aroma distribution is generated by chemical oxidation reactions, the microflora (bacteria and molds) in the smear and enzymatic anaerobic reactions in the centre of the cheese, respectively. The assumed variation in aroma perception associated with the inhomogeneous distribution of aroma active compounds was confirmed by the sensory tests and the CATA method. The different layers e.g. middle zone or central zone, contribute clearly to the qualitative aroma profile of the cheese. As a consequence, valuable knowledge for improved development and an adapted use of specific bacterial cultures or culture preparation for cheese production is provided. In addition, procedures of cheese sampling for analytical studies can be improved based on these findings.

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