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# Feasibility Study: Detection of "Rind Taste" Off-Flavour in Swiss Emmental Cheese Using an "Electronic Nose" and a GC-MS

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## Introduction

Processed cheese is a popular product on the Swiss cheese market. The cheese used for processed cheese production can come from three different sources: i) some cheese varieties are manufactured specially for this purpose; ii) cheese blocks with certain defects, e.g. the presence of too many eyes or splits making the blocks unsuitable for automatic packaging, or slight taste defects (but strong off-flavour would be noticeable in the final product); iii) the so-called cheese parings referring to the hoop side of the block coming from the packaging process. During the packaging process rectangular pieces are cut and packaged. The round pieces from the outer side of the blocks are set aside for the production of processed cheese. A significant proportion of the cheese used originates from Swiss Emmental cheese.

If the Swiss Emmental cheese used for the processing is not very well looked after during ripening in the cellar and/or stored before processing, it can develop a so-called "rind taste" off-flavour. This defect can easily be identified by tasting the cheese at the hoop side. The component(s) responsible for this off-flavour is(are) not eliminated during the manufacture of processed cheese, and can therefore also be felt in the final product. In order to ensure a high quality of the processed cheese, the cheese loaves used as raw material should be carefully treated during the ripening, and the parings should be used either fresh or stored in a freezing room, which slows down the oxidation process.

The volatile compounds from high quality Swiss Emmental cheese have been studied over the period of maturation in the cold room (1–3). The aim of the current study was to find out if the “rind taste” off-flavour is due to volatile compound(s) and could thus be detected by an “electronic nose” for on-line quality control and/or a GC-MS system.

## Materials and methods

### Samples

Four parings of Swiss Emmental cheese were examined: two with and two without “rind taste” off-flavour supplied from two factories.

### Electronic nose

The “electronic nose” used was a NST 3320 (Nordic Sensor Technologies AB, Linköping, S) equipped with 10 MOSFET and 12 MOS sensors.

The parameter settings were as follows: samples:  $2.00 \pm 0.002$  g of grated cheese; vials: 30 ml; carrier gas: ambient air; gas flow rate: 70 ml/min; measuring time: 30 s; system clean up: 20 min; standby temperature: 14°C; standby time: 20 min; incubation temperature: 50°C; incubation time: 20 min; syringe purge: 10 s.

As the water content of the samples may vary, a second experiment was performed with addition of 5 ml water to each vial.

Samples from factory one were measured three times for each experiment. Samples from factory two were measured six times for the first experiment and three times for the second experiment. The response of the sensor, defined as the last 30 % of the *sample* phase minus the *baseline* value, was used for PCA analyses.

### Gas chromatography

A cheese suspension was prepared by mixing 20 g finely grated cheese with 80 g cold water (10°C) using a high speed homogeniser (Polytron PT 3000 equipped with a PT-DA 3020s cutting system, Kinematica) running at 10 000 rpm for 1 min.

The measurements using the gas chromatography-mass spectrometer (GC-MS) system were performed with a purge-and-trap preconcentration technique. The instrument used was a Tekmar LSC 3100 (Cincinnati, OH, USA) equipped with a n° 8 trap, containing a mixture of Carbosieve SIII (0.05 g) and Carbopack B60/80 (0.2 g), set with the following parameters: sample: 10 g of cheese suspension; sparger: 25 ml non-fritted; purge gas: nitrogen 99.95 %; prepurge: 1 min; purge: 15 min at 45°C; dry purge: 10 min; purge flow rate: 30 ml/min; desorb preheat: 240°C; desorb: 4 min at 240°C; bake: 5 min at 260°C; valve: 150°C; line: 150°C; mount: 60°C; cryo focus temperature: -140°C; cryo inject: 1 min at 225°C.

The gas chromatograph (GC) was a Hewlett-Packard 5890, Series II with the following parameter settings: column: SPB-1 sulfur (Supelco) 30 m×0.32 mm id., film thickness: 4 µm; carrier gas: helium; gas flow: 1.6 ml/min; pressure: 40 kPa;



injection temperature: 45°C; temperature program: 13 min at 45°C, heating rate 5°C/min to 240°C, 5 min at 240°C.

The mass spectrometric (MS) detector was a HP 5972 operating in the scan mode (TIC) from 19 to 250 amu at 2.9 scan/s, ionisation by EI at 70 eV by autotuning; MS-Scan after 4.0 min.

## Results and discussion

### Electronic nose measurements

A difference could be observed when samples, with and without off-flavour, coming from the same factory were compared. However, when samples from both factories were pooled, a difference between good and tainted samples could no longer be observed (fig. 1).

Although the water content of the samples was not measured, the difference observed within a single factory could have been related to this component rather than to the off-flavour compound(s). To avoid this problem, water was added to the samples, so that this parameter was identical for all samples. The result obtained was

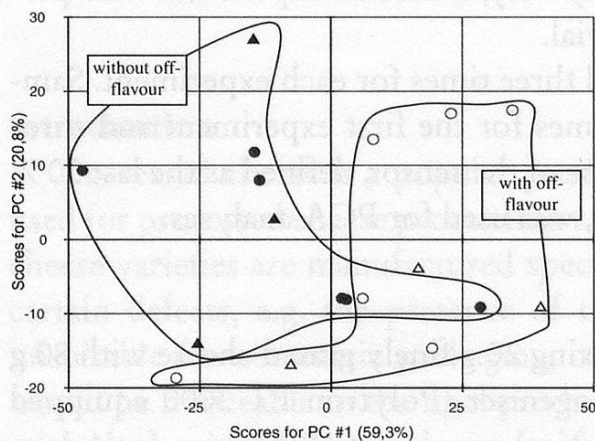


Figure 1 Tentative discrimination between Emmental with (empty symbols) and without (full symbols) off-flavour, coming from two different factories, triangles = factory 1 and circles = factory 2

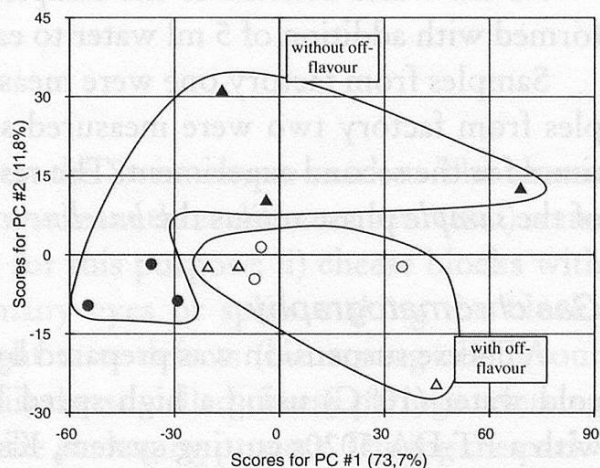


Figure 2 Tentative discrimination between Swiss Emmental cheese with (empty symbols) and without (full symbols) off-flavour, coming from two different factories, triangles = factory 1 and circles = factory 2.

Caption: Water was added to the samples in order to have the same water content in the samples

not better, which means that the NST3320 system was not able to detect this type of off-flavour (fig. 2).

At least three explanations are possible for this result: i) the instrument is not sensitive enough for the compounds responsible for this “rind taste” off-flavour; ii) these compounds were not volatile enough and therefore were not present in the headspace; iii) a too low repeatability leading to a large scattering of the measurements.

### GC-MS analyses

In order to gather more information about the components generating this off-flavour, GC-MS analyses were performed on the same samples (fig. 3).

The comparison of chromatograms with and without off-flavour revealed differences for the following compounds: 2-butanone, dimethyldisulfide, propyl propanoate, 1-hexanol, limonene, 2-nonanone and 2-undecanone. None of these compounds can, however, be related to this flavour defect, only to a difference in the stage of ripening between the two cheeses. The volatile off-flavour compounds

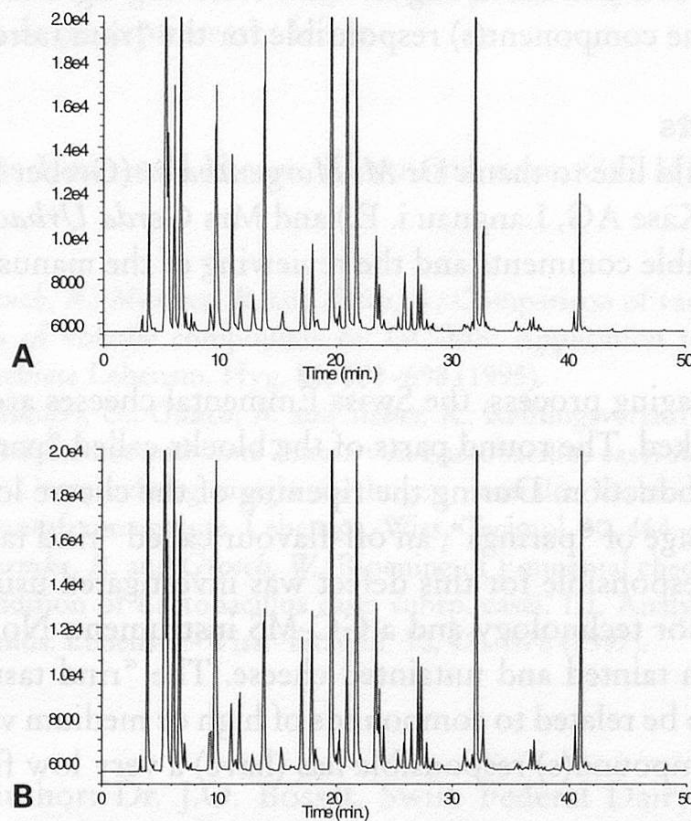


Figure 3 Chromatograms of Swiss Emmentaler cheese without off-flavour, A, and with “rind taste” off-flavour, B. The differences observed were: 2-butanone (1), dimethyldisulfide (2), propyl propanoate (3), 1-hexanol (4), limonene (5), 2-nonanone (6) and 2-undecanone (7)



usually induced by a beta- or a photo-oxidation of unsaturated fatty acids, i.e. alkanals, alkenals, alkanones and some aliphatic hydrocarbons, were not detected in the tainted cheeses. The other volatiles were the same as those found in good quality Swiss Emmental cheese.

A further investigation carried out in another laboratory did not show any 2,4,6- and 2,4,5-trichlorophenol, 2,3,4,6-tetrachlorophenol or pentachlorophenol in the tainted cheese (detection limit: < 0.005 mg/kg). In any case chlorphenols would not result from oxidation.

## Conclusion

The NST3320 system was not able to detect the off-flavour called "rind taste" in Swiss Emmental cheese. The analyses with GC-MS did not show any significant differences between tainted and untainted samples other than those due to the stage of maturity. No unusual suspicious compound could be identified in the cheese with off-flavour. The failure with these two techniques leads us to think that this taint could be related to compounds with very low volatility or to non-volatile compound(s). The fact that this defect is not detected by the human nose, but only by the taste, tends to confirm this explanation. The phenol compounds can also be excluded at least at concentrations higher than 0.005 mg/kg. Further analyses are needed to identify the component(s) responsible for the "rind taste" off-flavour.

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## Summary

During the packaging process, the Swiss Emmental cheeses are cut into rectangular pieces and packed. The round parts of the blocks called "parings" are used in processed cheese production. During the ripening of the cheese loaves used as raw material and/or storage of "parings", an off-flavour called "rind taste" can develop. The compound(s) responsible for this defect was investigated using an "electronic nose" based on sensor technology and a GC-MS instrument. No difference could be detected between tainted and untainted cheese. The "rind taste" off-flavour is therefore unlikely to be related to compounds of high or medium volatility. It is also possible that the compound(s) responsible has (have) a very low flavour threshold.

## Zusammenfassung

Emmentalerkäse wird in Verpackungsbetrieben entrindet, in rechteckige Stücke geschnitten und verpackt. Die runden Abschnitte der Laibe, die sogenannten Randstücke, werden für Schmelzkäse verwendet. Bei der Reifung der als Ausgangsmaterialien verwendeten Käselaipe oder/und der Zwischenlagerung solcher Randstücke

vor dem Schmelzen kann der typische Fehler «Rindengeschmack» auftreten. Mit Hilfe einer «elektronischen Nase» mit Sensortechnologie und einem GC-MS wurde nach den verantwortlichen Geschmackskomponenten gesucht. Zwischen Stücken mit oder ohne Fremdgeschmack konnte kein Unterschied festgestellt werden. Der «Rindengeschmack» ist sehr wahrscheinlich nicht auf die stark oder mittelflüchtigen Komponenten zurückzuführen. Es ist auch möglich, dass diese Komponente(n) einen sehr niedrigen Aromaschwellenwert aufweist(en).

## Résumé

Dans les usines d'emballage, les fromages Emmental sont d'abord écroûtés, puis coupés en morceaux rectangulaires avant d'être emballés. Les parties rondes, appelées «talons», des meules sont utilisées pour la fabrication de fromages fondus. Pendant l'affinage des meules utilisées comme matière première pour la fabrication des fromages fondus et/ou pendant le stockage de ces talons, un défaut de goût dit «goût de croûte» peut se développer. Le(s) composé(s) responsable(s) de ce défaut a(ont) été étudié(s) à l'aide d'un «nez électronique» basé sur la technologie des capteurs, ainsi qu'avec un GC-MS. Aucune différence n'a pu être détectée entre des fromages avec et sans défaut. Les composés très ou moyennement volatils ne sont donc pas à l'origine du «goût de croûte». Il est également possible que ce(s) composé(s) présente(nt) un seuil de perception très faible.

## Key words

Off-flavour, Swiss Emmental cheese, Electronic nose, GC-MS, Ripening, Parings

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