Quality of Fermented Sausage evaluated using an Electronic Nose as compared to Sensory Analysis and Analysis of Volatile Compounds using Headspace Gas Chromatography/Mass Spectrometry

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Background

The flavour of food is a complex mixture of many different compounds. The contribution of each compound depends on the concentration and the olfactory threshold. Headspace gas chromatography combined with mass spectrometry (GCMS) has been extensively used in the separation and identification of volatile compounds from different foods. These analyses give a complex pattern of the volatiles, which may be used as a fingerprint of the product. On the other hand, sensory analysis gives a description of the food flavour, both qualitatively and quantitatively. Both analysis of the volatile compounds using GCMS and sensory analysis are time-consuming as well as expensive, as there is a need for advanced technical equipment and skilled personnel. Rapid, robust and reproducible analytical methods are essential in quality control. The measurement of volatiles using non-specific gas sensors combined with methods of pattern recognition, called artificial olfaction or electronic nose (Gardner and Bartlett, 1991) is a new and interesting approach in flavour analysis, which may be used in quality control. Electronic noses have been successfully used in some applications of relevance to meat, such as evaluating the quality of ground meat (Winquist *et al.*, 1993), spoilage of meat (Blixt and Borch, 1996), sausage fermentation (Eklöv *et al.*, 1998) and to study the desorption of volatile compounds of sausages (Berdagué and Talou, 1993).

Objectives

Evaluate the use of an electronic nose in the quality assessment of fermented sausage as compared to sensory analysis and GCMS of volatile compounds.

Methods

Eight different batches of a fermented sausage, using one recipe, were produced in a pilot plant according to Johansson *et al.*, 1994.

The sensor array of the electronic nose comprised 14 different sensors of two types, 10 metal oxide semiconductor field-effect transistors (MOSFETs) and 4 Taguchi type, doped semiconducting chemoresistors (TGS). For the analysis, 50 g of each sausage were equilibrated in a sealed beaker for 10 min at room temperature. The measurement procedure consisted of pumping clean air (ambient air filtered through active carbon) for 4 min over the sensors and then pumping sausage headspace gas for 30 s. The measurement sequence (batches 1 to 8) was repeated 30 times and the mean of these 30 measurements of each sausage was used in the evaluation.

For the headspace sampling of volatile compounds, 10 g of homogenised sausage were equilibrated for 30 minutes at 25 °C. The volatile compounds were absorbed on a Tenax trap (Tenax TA, 60-80 mesh) with helium. GCMS analysis was performed on a GC 8000 gas chromatograph (Fisons, Fisons Nordic AB, Solna, Sweden) connected to a Trio-1000 mass spectrometer (VG Masslab, Fisons Nordic AB, Solna Sweden). The chromatographic conditions were: a HP-1701 capillary column, 0.25 mm x 30 m, film thickness 1.0 µm (Hewlett-Packard Sverige AB, Kista, Sweden); oven temperature 30°C for 10 min and 30 to 250°C with a slope of 5°C min^{-1}; helium flow 1 ml min^{-1}. Electron impact mass spectra were recorded with an ionisation energy of 70 eV. The volatile compounds were tentatively identified from a library search (NIST/NBS).

The sensory analysis was carried out by 17 trained judges. The sensory profiles of the sausages were determined using an unstructured line with end points (1-9), where 1 = no smell or taste and 9 = very strong smell or taste. The following attributes were evaluated: smell intensity; acid smell; smoky smell; garlic/onion smell; pungent acid taste; mild acid taste; garlic/onion taste; spicy taste; aromatic taste.

Principal component analysis (PCA) was performed using The Unscrambler 6.11 (Camo AS, Trondheim, Norway).

Results and Discussions

There were variations among the different sausages in the responses from the electronic nose (Fig. 1), as well as in the sensory scores (Fig. 2) and the volatile compounds (Fig 3). Sausage 1 was clearly differentiated from the other sausages by all the techniques. This sausage was separated by sensor MOS7 of the electronic nose (Fig.1), by the sensory attributes smell intensity and garlic onion smell and taste (Fig. 2) and by the volatile compounds D-limonene and 3-carene (Fig. 3). Garlic and onion are strongly associated with volatile compounds, which may explain the good discrimination of this sausage also by the electronic nose, as well as by the GCMS analysis. The terpenes D-limonene and 3-carene, with characteristic odours, have been identified both in pepper (Kollmansberger *et al.*, 1992) and in meat and meat products (Wittkowski *et al.*, 1990). Knowledge of the sensitivity of the electronic nose sensors to different types of volatile compounds is so far limited, and it is not possible to confirm whether the two terpenes are also related to the gas sensor MOS7. Furthermore, it is very difficult to compare scores from sensory analysis with the amount of volatile compounds, as the volatiles may have very different odour thresholds. In garlic (Yu *et al.*, 1989) and onion (Fenwick and Hanley, 1985) many sulphur compounds, related to the typical taste, have been identified. Such sulphur compounds were found in the sausages (Fig.3), although in lesser amounts than the terpenes. Nevertheless, these sulphur compounds may contribute more to flavour, due to lower odour threshold values, than the terpenes. When PCA was applied to the responses from the electronic nose combined with sensory scores and volatile compounds, respectively, the sensors were most associated with the sensory attribute spicy taste and volatile compounds such as terpenes and sulphur compounds (data not shown).

Conclusions

It was possible to detect differences between eight batches of fermented sausage. One of the sausages was clearly differentiated from the others using three analysis techniques, electronic nose, sensory analysis and headspace GCMS. Since the electronic nose technique is rapid, simple and robust, further development of quality measurements of fermented sausage would be very attractive.

Literature

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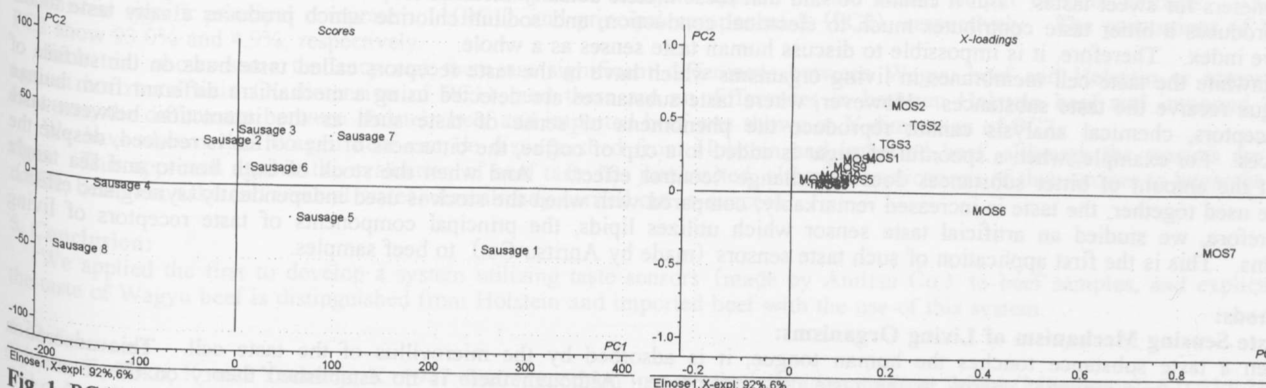

Fig. 1. PCA (scores and loadings) of the responses from the electronic nose. Two PCs explained 98% of the variation. Sensors: MOS1-10 and TGS1-4.

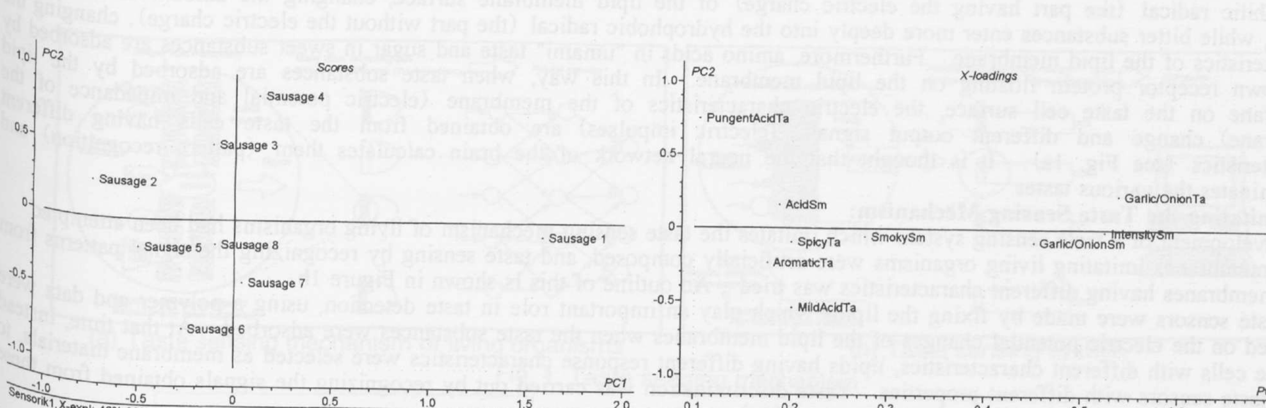

Fig. 2. PCA (scores and loadings) of the sensory scores. Two PCs explained 76% of the variation. Sm = smell, Ta = taste.

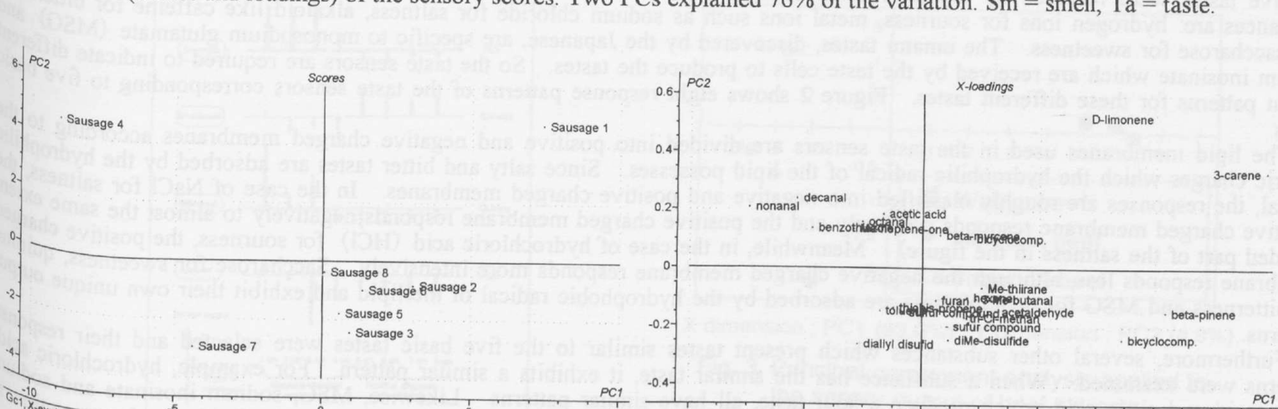

Fig. 3. PCA (scores and loadings) of the volatile compounds (GCMS). Two PCs explained 75% of the variation.