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Potential application of electronic nose in processed animal proteins (PAP) detection in feedstuffs

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Electronic nose and olfactometry techniques represent a modern analytical approach in food industry since they could potentially improve quality and safety of food processing. The aim of this study was to evaluate possible application of electronic nose in PAP detection and recognition in feed. For this purpose 6 reference feedstuffs (CRA-W / UE STRATFEED Project) were used. The basis of the test samples was a compound feed for bovine fortified with processed animal proteins (PAP) consisting of meat and bone meal (MBM) and/or fish meal at different concentrations. Each feed sample was tested in glass vials and the odour profile was determined by the ten MOS (metal oxide semi-conductor) sensors of the electronic nose. Ten different descriptors, representing each ten sensors of electronic nose, were used to characterise the odour of each sample. In the present study, electronic nose was able to discriminate the blank sample from all other samples containing PAP (MBM, fish meal or both). Samples containing either 0.5% of MBM or 5% of fish meal were identified, while samples containing a high fish meal content (5%) associated with a low MBM content (0.5%) were not discriminated from samples containing solely fish meal at that same high level (5%). This latter indicates that probably the high fish meal level, in samples containing both MBM and fish meal, tended to mask MBM odour. It was also evident that two odour descriptors were enough to explain 72.12% of total variability in odour pattern. In view of these results, it could be suggested that electronic nose and olfactometry techniques can provide an interesting approach for screening raw materials in feed industry, even though further studies using a wider set of samples are needed.

Keywords. PAP determination, electronic nose.

1. INTRODUCTION

Regulation 178/2002 of the European Parliament and Council, concerning the principles and requirements for food law, states that all aspects of food production must be considered to ensure the safety for human food. Among crucial points the production, manufacture, transportation and distribution of feedstuffs for food-producing animals are also considered. As a result, farmers, nutritionists, industry and governments have been obliged to pay serious attention to animal feedstuff production processes and usage, and acknowledged that animal feed safety is an essential prerequisite for human food safety. For this reason it is important to develop simple, rapid and cost-effective analytical methods capable of detecting, identifying and quantifying the numerous feedstuffs contaminants. These methods must be widely applied in order to enforce the new legislation and limit illegal substitution and fraud (Moretti *et al.*, 2003; Pinotti *et al.*, 2003). Obviously, the combination of these requirements with the need for accurate, fast and objective determination of feed quality and safety standards could be very difficult.

Electronic nose and olfactometry techniques represent a modern analytical approach in food industry since they could potentially improve quality and safety of food processing. Electronic noses consist of non-specific chemical detectors which can help to identify and quantify odours by means of a pattern recognition system (Feast, 2001). Among the different applications of the electronic nose, foodstuffs analysis is one of the most promising and also the most important (Di Natale *et al.*, 2001a; 2001b; Magan, Evans, 2000; Mielle, 1996), probably because it represents a fast, automated, non-destructive and cost-effective alternative assay. Thus, the aim of this study was to evaluate possible application of electronic nose in processed animal proteins (PAP) detection and recognition in feed.

2. MATERIALS AND METHODS

For this study six reference feedstuffs (Walloon Agricultural Research Centre of Gembloux, Belgium,

STRATFEED Project – www.stratfeed.cra.wallonie.be) were used. The main matrix of the test samples was a compound feed for bovine, fortified with PAP (meat and bone meal (MBM) and/or fish meal) at different concentration:

– sample A, 0.5% MBM
– sample B, 0.5% MBM + 5% Fish meal
– sample C, 5% Fish meal
– sample D, blank (PAP absent)
– sample E, 0.5% MBM
– sample F, 0.5% MBM + 5% Fish meal.

The same amount (1.2 g) of each feed sample was equilibrated at 40° C temperature for five min in glass vials and the odour profile of the six samples was determined by the 10 MOS (Metal Oxide Semi-conductor) sensors of the electronic nose pen2 (Airsense Analytics GmbH, Schwerin, Germany). The sampling time was 3 min and the flush time between two sampling was 4 min. The flow rate was 400 ml/min. Four replicates were taken for each feed sample. Ten different descriptors, representing each ten sensors of electronic nose (1: "Aromatic1", 2: "Broadrange", 3. "Aromatic3", 4: "Hydrogen", 5: "Aromatic-aliphatic", 6: "Broad-methane", 7: "Sulphur-organic", 8: "Broad-alcohol", 9: "Sulphur-chlor", 10: "Methane-aliphatic"), were used to characterise the odour of each sample. Results (taken at the same moment of sampling time and with the same mass of 1.2 g) of all six samples were radar plotted (**Figure 1**). For each analysis, only the last ten seconds of the measure were included in the data set (a total of 2400 observations) because of their higher homogeneity. The data were analysed using the PRINCOMP (Principal Component Analysis, PCA) and CLUSTER (Ward's Minimum Variance Cluster Analysis) procedures of SAS (2001). PCA reduces the dimension of the data-set by eliminating the non-representative variables (sensors). CLUSTER analysis groups the observations and depicts a hierarchical tree according to the similarity among samples.

3. RESULTS AND DISCUSSION

In the present study electronic nose was able to discriminate the blank sample from all others samples containing PAP (MBM, fish meal or both). Samples containing the 0.5% of MBM (sample A and E) and 5% of fish meal (sample C) were identified (**Figures 2, 3**), while samples containing a high fish concentration (5%) associated with low MBM content (0.5%) were not discriminated from samples fortified with 5% of fish meal solely (**Figures 2, 3**). We can suppose that fish flavour is able to mask MBM odour, that was not detected by the electronic nose. Furthermore the PRINCOMP analysis showed that 72.12% of total data variability (referred to odour

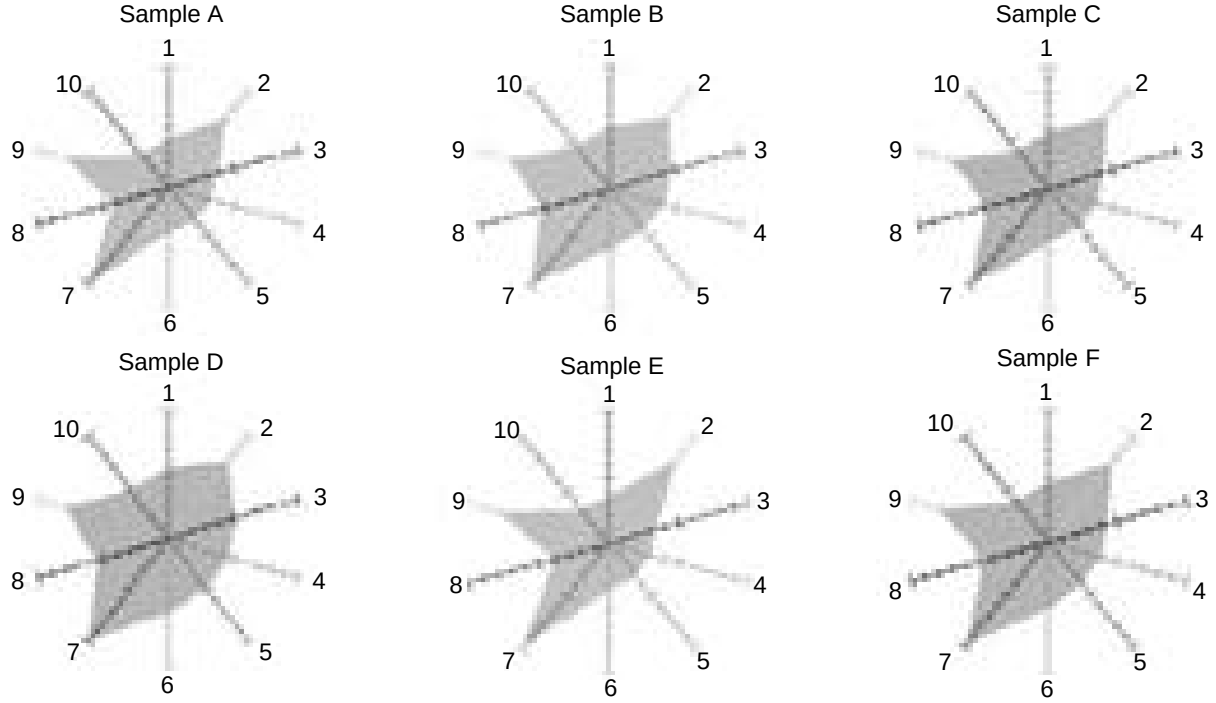

Figure 1. Electronic nose measurements Radar Plot (175 sec) for each sample class. Sample A, 0.5%MBM; Sample B, 0.5% MBM+5% Fish meal; Sample C, 5% Fish meal; Sample D, blank (PAP absent); Sample E, 0.5% MBM; Sample F, 0.5% MBM+5% Fish meal. The number of each axis corresponds to the prameter number given in Materials and methods.

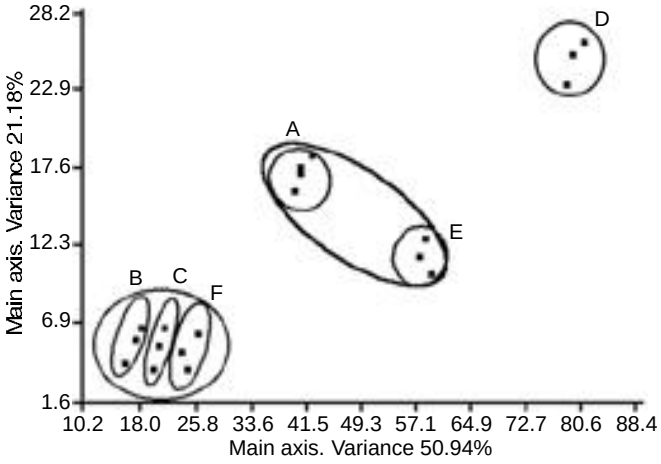

Figure 2. Results of Principal Component Analysis. Sample A, MBM 0.5%; sample B, MBM 0.5%+ Fish meal 5%; sample C, Fish meal 5%; sample D, blank (PAP absent); sample E, MBM 0.5%; sample F, MBM 0.5% + Fish meal 5%.

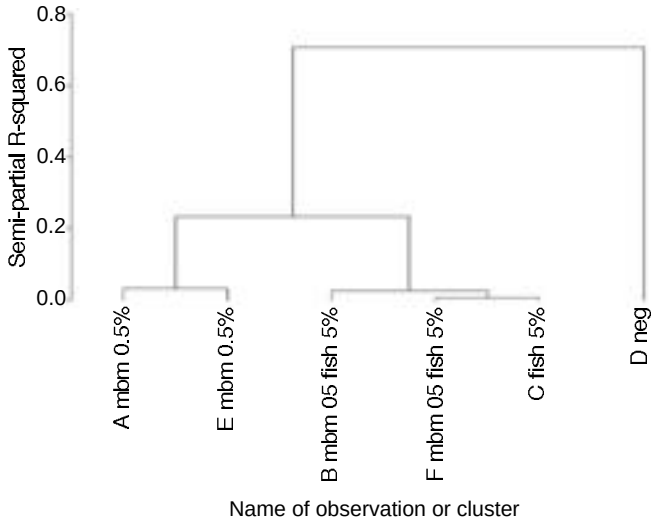

Figure 3. Results Ward's Minimum Variance Cluster Analysis.

profile) was explained by only the two first principal components (corresponding to the two electronic nose sensors sulphur-organic and broadrange). The sum value of remaining eight components (corresponding to the last 8 sensors) explained the rest of the variability (27.88%).

The results showed that the electronic nose was able to detect PAP in samples containing a MBM at level as low as 0.5%, suggesting a novel finding concerning the development of new PAP's analytical methods. This technology was also able to distinguish between MBM and fish meal, even if it was not possible to differentiate meat and bone meals from fish meals when jointly present in the sample (0.5% MBM + 5% Fish meal, possibly due to the masking of meat and bone odour by the fish meal odour).

This study demonstrated that the electronic nose is a promising analytical approach to PAP detection in feedstuffs, particularly for screening of raw materials in the feed industry. However, further studies involving larger sample groups characterized by different kinds of animal meals and a wider variety of contamination levels as well, are needed.

Further studies are also necessary to determine the real potential of the technique in this field. For instance, as suggested by Feast (2001), increasing the number of samples contaminated with known PAP concentrations and testing other independent samples, could be a way to test the robustness of the models.

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