APPLICATION OF ELECTRONIC NOSE FOR RAPID IDENTIFICATION OF DIFFERENT POULTRY MEAT SAMPLES: PRELIMINARY RESULTS

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Background

Volatile compounds and their changes in particular can be used as the indicators of chemical, enzymatic, microbiological and other processes that occur in meat during its handling and storage. Traditional techniques for the isolation and quantification of volatile compounds, e. g. headspace, distillation and extraction are usually laborious and time consuming. Therefore, the methods for the rapid detection and assessment of volatiles in a food matrix are of great practical importance. In an electronic nose, raw signals from an array of the sensors are usually pre-processed before the database of signals is analysed with the mathematical tools, e.g. principal components analysis or neural network. Both static and dynamic responses of the sensors could be used to build up a database for the analysis. If the transient response is detected, large number of data points is collected in the test. Recently [1], a method was proposed for identification of odours based on an exponential decay of the response signals. It was demonstrated that this approach is acceptable for the recognition of the target smell by a neural network even if the input database is collected from a single sensor. In the present report, the improved pre-processing technique was used for the analysis of the transient responses of the metal oxide sensors exposed to the effluent volatile constituents from chicken meat. The report deals with the possibilities to distinguish between the target gases based on the 2D-τ-images composed of the parameters obtained from the transient response analysis.

Objectives

This study was aimed at the assessment of odour components emitted from different poultry meat samples by a dynamic response electronic nose. The 2D-τ-imaging was composed for visual inspection of the odours and the possibility to distinguish between poultry meat samples by the dynamic response electronic nose was attempted.

Methods

Chicken meat samples were obtained from the local poultry plant. The meat was minced and divided into the two parts, one of which was contaminated with *Pseudomonads* species cultivated in the tryptone soy broth. The concentration of pure broth was $6{,}4\times10^8$ cells/1g. CFU in the control meat after sample preparation was $1{,}10\times10^4$ while in the contaminated $3{,}10\times10^7$. Meat samples were stored at +15 °C and microbial characteristics, the content of volatile fatty acids (VFA) and thiobarbituric acid reacting substances (TBARS) were determined at timed periods. An array of gas sensors was periodically exposed to the volatile constituents released from the meat. The array was composed of ten home-made sensors based on tin and indium oxides. The test chamber with the array was connected to an automatic two-flow control system. In the system, switching between the flow of clean synthetic air and the target odour produced a steep change in gas composition of air. The sample of the target odour was blown by a flow of synthetic clean air from a glass container with a piece of chicken meat sample. The database of the response signals was composed in the 2D-τ-charts according to the original method, which is described elsewhere [1].

Results and discussion

After an injection of the sample volatiles, the relative signal of any of the sensors (U_{resp}/U_0) decreased in response to the odour of the meat sample and tended to a stabile value after some time. The transients were fitted with an exponential decay and the sets of the parameters were collected for each of the tests. A collection of the parameters was composed of a series of the pairs consisting of the parameters named (τ_i, a_i) that were evaluated for each of the sensors. For single sensor, the sets of the parameters could be plotted in a 2Dτ-image as it is illustrated in Fig.1. The results in this figure are demonstrating possibility to distinguish between the odour of different samples of poultry meat by the response of a single sensor. The accuracy of the recognition was increased by summarising the responses of all the sensors in the array.

For the visualisation of the transient response to gas, each pair of the parameters (τ_i, a_i) was supposed to be the co-ordinates of a point in a polar plot. The plot was summarizing all the time components of each sensor and all the sensors in the array. Composition of the plots was strictly determined. In Fig. 2, typical plots (2Dτ-images) are illustrated for the response of the array to two types of the target odour samples (a and b). In each plot, the set of the time constants corresponding to the same number of the sensors analogous parameters of which were connected with closed line. Three sets were revealed for each of the analysed samples in Fig. 2a and 2b. The difference between the odours is evident from visual inspection of the plots consisting of three or four closed lines. In fact, individual line is representing "additional" feature of the odour. Consequently, an odour was distinguished from the others if the shape of any of the "features" was different.

The 2Dτ-images were employed for identification of ageing of the meat. In Fig. 3, the images were plotted for a control meat at different stages of the ageing in hours. The degeneration was not distinguished for the meat within initial period of about 20 hours. After that, the difference was indicated for the features "2" and "3" in Fig. 3 (labels "0" and "26"). The difference was much more evident for the meat after longer ageing. Pure sensitivity of the nose to the ageing within the initial period was related to an increase of the intensity of the odour while the composition of the odour was nearly unchanged. Contrary to this, the qualitative change of the odour was recognised by visual inspection of the images.

The sensitivity of the method to qualitative changes in the odour was demonstrated by the tests with the infected poultry meat. In Fig. 4, the 2Dτ-images were obtained for the meat infected with *Pseudomonads aeruginosa*. In the images, the infected meat was distinguished from the clean one by the features "2" and especially "3" even at the very beginning of the ageing (compare Fig. 3 "0" and Fig. 4 "0"). The difference was much more evident for the meat after longer ageing. The difference between the 2Dτ-images of the clean and infected meat were explained by qualitative changes in the odour originated by the infection. It was supposed that volatile products unique to the activity of the bacteria were present in the odour of poultry meat.

The amount of FVA constantly increased during storage, and the increase was more remarkable in the infected meat. The changes in the content of TBARS was more complex and less significant, most likely due to the very slow oxidation processes in the lean meat at the used temperature and storage time. It is interesting to note that at the end of the storage the number of microorganisms expressed in CFU was

almost equal both in the control and infected meat samples. Most likely, intentionally added *Pseudomonads aeruginosa* suppressed the propagation of other microflora. At the present, rather preliminary stage of the study it was not possible to find any correlation between measured chemical and microbiological changes and electronic nose responses during storage.

Conclusions

Electronic nose consisting of an array of gas sensors can clearly discriminate different poultry meat samples, particularly those infected with *Pseudomonads* species. However, for the development of a reliable techniques for the rapid detection of the specific microbial infection and/or ageing clear correlation between electronic nose response and chemical effluents and/or changes should be established.

Pertinent literature

1. A. Galdikas, A. Mironas, D. Senuliene and A. Setkus. 2000 Sensors and Actuators B. 69 258-265.

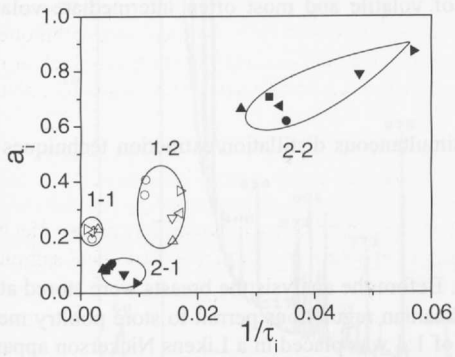

Fig. 1. 2D-τ-image composed of the parameters (τ_i, a_i) evaluated from the response of the sensors 2 in Fig.1 and representing fresh non-infected meat (1-1 and 1-2) and the sample infected with bacteria *Pseudomonads mirabilis* (2-1 and 2-2).

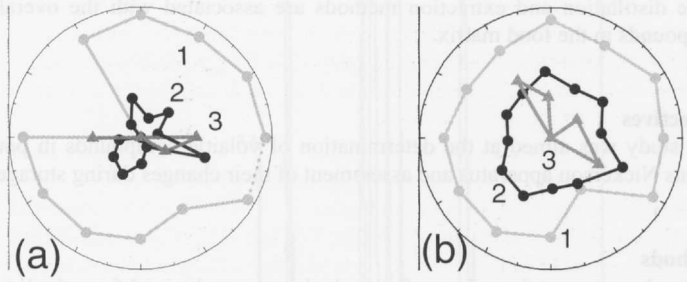

Fig. 2. Multi-component 2Dτ-images based on the transient responses of 12 metal oxide sensors to the volatile of fresh meat: (a) whole piece of muscular tissue and (b) the mince

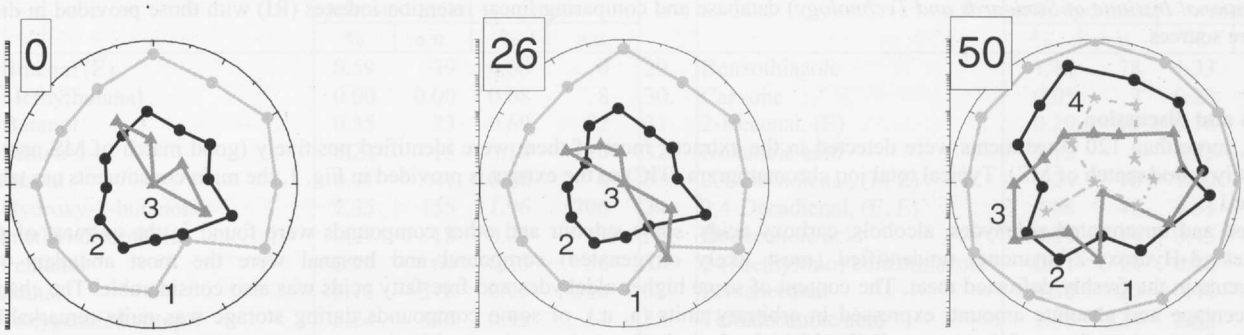

Fig. 3. Multi-component 2Dτ-images based on the transient responses of 12 metal oxide sensors to the smell of fresh chicken (mince) that was stored att +15 ºC for different period in hours (from left to right): 0 h; 26 h; 50 h.

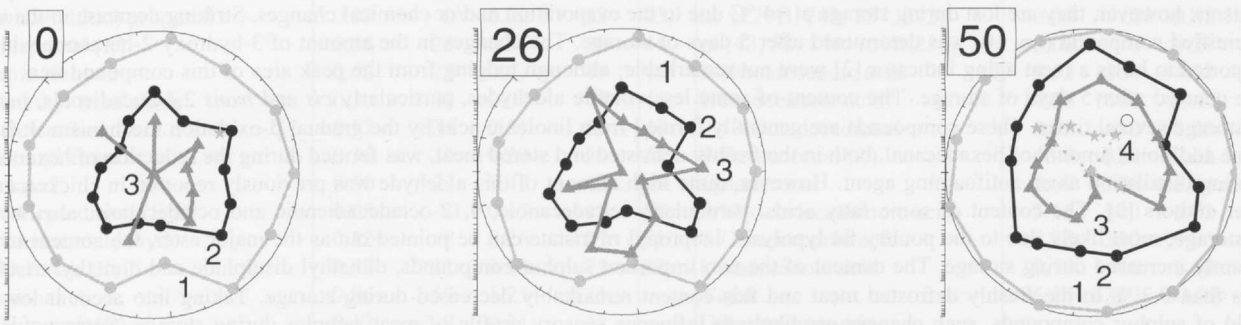

Fig. 4. Multi-component 2Dτ-images similar to that in Fig. 3 except for the fact that the meat was infected with *Pseudomonads aeroginosa*; period of the storage in hours (from left to right): 0 h; 26 h; 50 h.