

Sensory systems: use in fresh meat quality control

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Abstract

The “VOCmeter” (electronic nose) was used for meat quality research. The experiment consisted of two parts: 1) to work out method of meat freshness evaluation; 2) to investigate the potential of the «VOCmeter» for meat species detection. Freshness of pork samples was examined by conventional methods and by the “VOCmeter”. As a result two calibration charts of freshness were obtained (the charts for muscular and fatty tissues). During the second part of work different meat samples (beef, pork; reindeer, poultry, ostrich meat, etc.) were examined with “VOCmeter”. The calibration chart revealed a significant difference between the samples. The results confirmed expediency in using the electronic nose for meat freshness evaluation and meat species belonging. The advantages of these methods are simplicity and rapidity in carrying out of the experiments.

Introduction

For quality control of foods organoleptic attributes are conventionally used, evaluated with the help of organs of vision, taste and smell. Due to increase of objectivity of the results being obtained, the organoleptic attributes become more valuable when the information about quality is added with quantitative information, obtained with the help of analytical methods.

At the end of 1980s a scheme of simultaneous treatment of analytical signals from a group of non-selective sensors has been developed. With the use of multi-sensory system it is possible to obtain rather accurate information both about composition and concentration of components of multi-component gas mixtures. A new type of artificial analytical systems – “electronic nose” has become a result of these investigations. “Electronic nose” is the analyzer of vapors and gases on the basis of heterogenous sensors, imitating the functions of olfactory organs of a human. The sensory system provides obtaining of a recognizable image of the analyzed mixture of vapors of smelling substances which can contain hundreds of different chemical compounds. “Electronic nose” consists of sensors that are selected by their chemical affinity to single components of the analyzed mixture of gases and vapors. Each sensor has different sensitivity to the compounds to be analyzed and the specific profile of responses to smells to be tested.

The objective of these investigations was to create the technique allowing identification of freshness of meat raw materials and evaluation of potentials of “VOCmeter” (“electronic nose”) for the determination of species of meat raw materials.

Materials and methods

The device “VOCmeter” from “AppliedSensor” (Germany) is a system, containing four sensors MOS (metal oxide sensor) and eight sensors QMB (quartz microbalance sensor).

Results

As previous investigations have shown, to increase the reliability of evaluation results it is expedient to sample from the surface and deep layers of the analyzed specimens of meat raw materials, and for the determination of species of meat – from deep layers [1]. In the investigations of meat raw materials it is helpful to use the data of the sensors MOS₁ – MOS₄, in this case the sensors MOS₁ and MOS₄ have a pronounced affinity to the components, being formed at the initial stages of raw materials spoilage and forming acidic, fusty and tallowy smell. Sensors MOS₂ and MOS₃ describe the substances accumulating at the stage of deep spoilage of meat raw materials and forming putrefactive smell of muscular and rancid smell of fat tissue [2].

On the basis of meat raw materials investigations (chemical, sensory, microscopic, histological methods) the calibration charts were obtained (for muscular and fat tissue) of spatial arrangement of points during treatment by the method of principal component analysis (PCA) of VOCmeter sensors MOS₁-MOS₄ readings, allowing differentiation of the categories of meat raw materials freshness. The obtained calibration charts are presented in Figures 1 and 2.

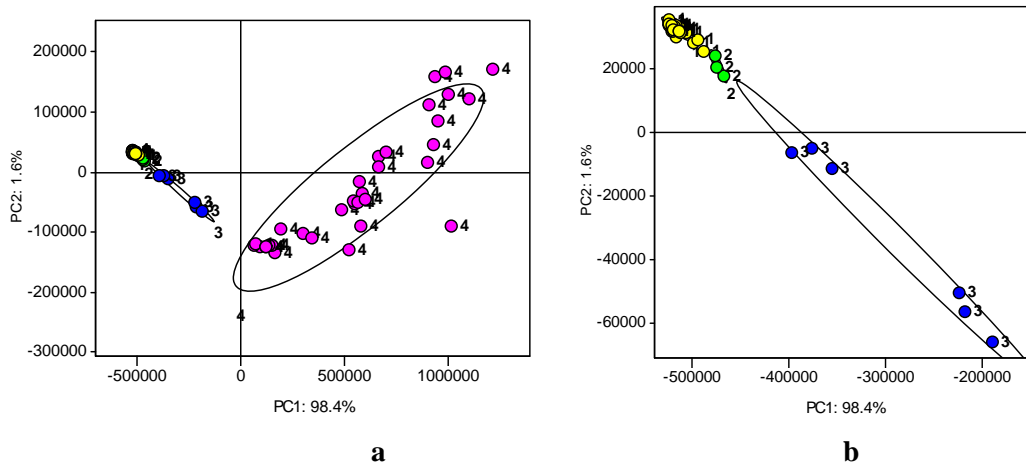


Figure 1. a) Calibration chart of spatial arrangement of points during treatment by the principal component method of sensors MOS₁-MOS₄ readings of VOCmeter in the investigations of muscle tissue samples of 4 categories of freshness (1-fresh meat; 2- fresh, not intended for long storage; 3- doubtful freshness, 4 - not fresh); b) Fragment of the chart : a) for muscular tissue samples of three categories of freshness (fresh; fresh, not intended for long storage; doubtful freshness).

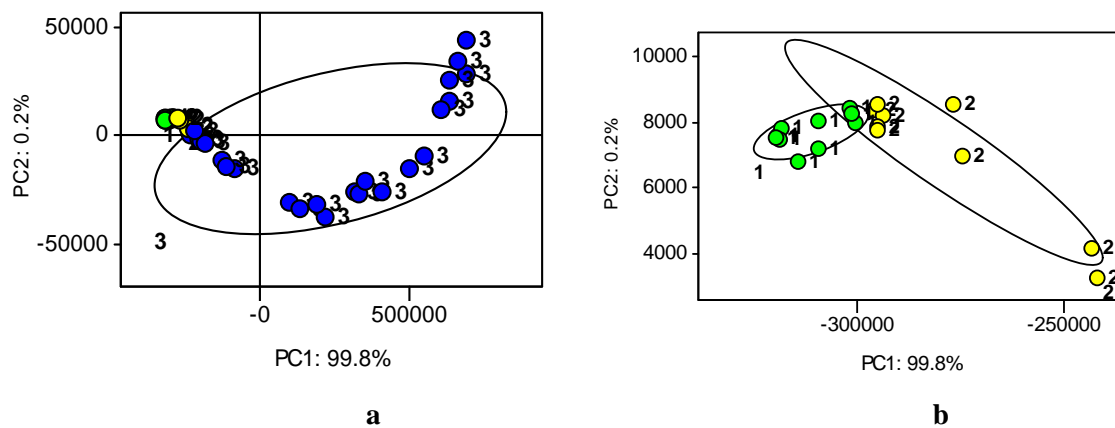


Figure 2. a) Calibration chart of spatial arrangement of points during treatment by the principal component method of sensors MOS₁-MOS₄ readings of VOCmeter in the investigations of fat tissue samples of 3 categories of freshness (1-fresh; 2- doubtful freshness; 3- not fresh); b) Fragment of the chart : a) for fatty tissue samples of two categories of freshness (fresh and doubtful freshness).

The use of the principal component analysis allows concentration of the main information, expressing a large number of the considered signs through a less number of more capacious internal characteristics. Fig. 1 shows that the area of points, characterizing fresh samples, is located in the fourth quarter of coordinate system and it's not large in size. The area of points, characteristic of the samples of "doubtful freshness" has greater size and is located in the third quarter of coordinate system. The area of points, determining not fresh samples, has the largest size and is located in the first and second quarters of coordinate system. It should be noted, that the area characterizing not fresh samples of muscular tissue, has greater values of the principal component PC1 (has larger coordinates of abscissa axis). In connection with this, the borders of values of the principal component PC1 for four categories of freshness of muscular tissue were established (Table 1).

Table 1. Values of the principal component (PC1) for four categories of freshness of muscular tissue

Name of the principal component	"Fresh"	"Fresh, not to be subjected to long storage"	"Doubtful freshness"	"Not fresh"
PC1	Less (-467000)	(467000) \pm (-433000)	(-433000) \pm (-189166)	More (-189166)

From Figure 2 it can be seen, that the location of the areas of points, characteristic of the samples of fatty tissue, is similar to the location of the points, characterizing the samples of muscular tissue of the corresponding categories of freshness. The borders of values of the principal component PC1 for three categories of freshness of fat tissue are presented in Table 2.

Table 2. The values of the principal component for freshness category of fat tissue

Name of the principal component	“Fresh”	“Doubtful freshness”	“Not fresh”
PC1	Less (-300000)	$(-300000) \pm (-245000)$	More (-245000)

On the basis of the investigations the guidelines for the evaluation of meat freshness using VOCmeter have been developed, which are successfully used at the present time for the determination of time and conditions of storage, in the works for quality evaluation in the case of violation of storage conditions and in other research work.

Along with the use of VOCmeter for the evaluation of meat raw materials freshness, the possibilities of its use for the determination of species of meat and revealing meat adulteration were determined. The following meat species were used as the objects of analysis on VOCmeter: pork, beef, lambmeat, deer meat and poultry (chickens, ostrich, turkey) fish. Four samples were prepared from each species of the raw materials. The readings of the sensors MOS₁-MOS₄ obtained during raw materials investigations, were treated by the principal component method (Figure 3).

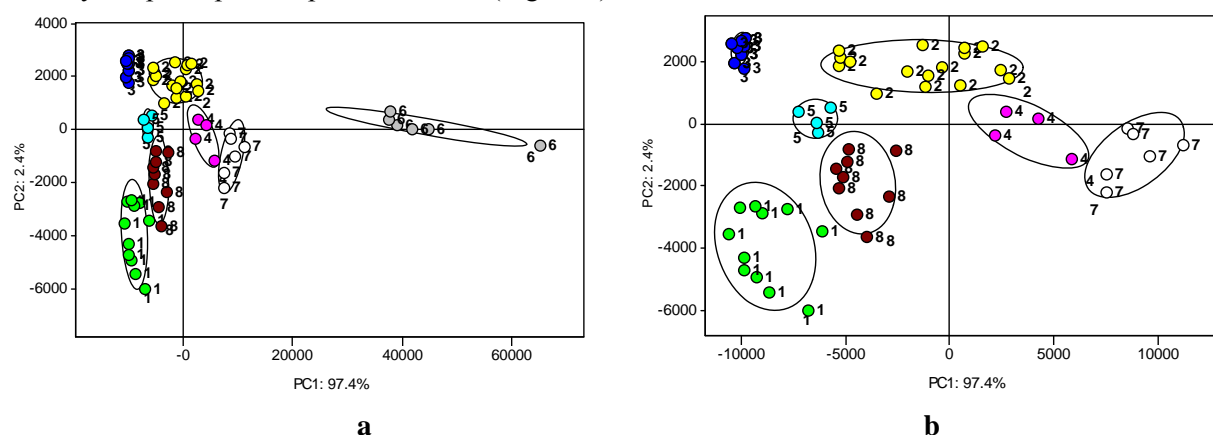


Figure 3. Spatial arrangement of points during treatment by the method of principal components of sensors MOS₁-MOS₄ readings of VOCmeter during investigation of muscular tissue of samples of different species (1- pork; 2- beef; 3- chickens; 4- fish; 5 – lambmeat; 6- deer meat, 7- ostrich, 8 – turkey).

Figure 3 shows that the areas of points characterizing each species of meat, are located at a close distance from each other, which allows to reveal the areas (clusters) characterizing each kind of the meat raw materials separately. In this case it should be noted that the clusters can be located next to each other, while not intersecting, which will allow carry out the analysis of meat raw materials species with high reliability.

To increase evaluation objectiveness of meat freshness and introduce the express methods, allowing to reduce time and expenses for tests, and to avoid controversy, arising when conventional methods of investigations are used, the Institute now carries out work on improvement and adaptation of the electronic nose for the production conditions of food plants laboratories. The results suggest that sensory systems will take a worthy place if food quality analysis.

References

- Chernoukha I.M., Kuznetsova T.G., Selivanova E.B. 2008. Use of sensory system “VOCmeter” for quality evaluation of meat raw materials, *Myasnaya industriya*, №4, pp. 9-11.
- Chernukha I.M., Kuznetsova T.G., Selivanova E.B., Ivankin A.N. 2008. Use of “VOCmeter for meat quality investigation, *Myasnaya industriya*, №3, pp. 45-48.