9TH INTERNATIONAL WORKSHOP ON SURFACE ENGINEERING
5TH INTERNATIONAL WORKSHOP ON APPLIED AND SUSTAINABLE ENGINEERING
20.06. – 26.06.2021, Koszalin University of Technology

Green chemistry – voltammetric food profiling without supporting electrolyte

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Green chemistry

One of the inherent elements of experiments with the use of voltammetry is the selection of the support electrolyte. The task of the support electrolyte is to provide conductivity during determinations or profiling. It is often responsible for maintaining the correct pH in the measuring cell. Its proper selection is often of key importance for the quality of the results obtained. Electrolytes can be very simple substances [1-3], but they can also be very complex and consist of a mixture of several chemicals [4].

Globally, more and more emphasis is placed on ecology. This applies primarily to various branches of the economy, but also to science [5]. The development of "green chemistry" undoubtedly affects the neutralization of the impact of the development of science on the natural environment. The main trend in green chemistry is to minimize the use of chemicals that can adversely affect the environment.

The poster shows the results of an experiment that omitted the support electrolyte in voltammetric food profiling. The subjects of the research were honey and coffee samples. The supporting electrolyte was not used during the profile registration. In this experiment, the tested samples acted as an analyte as well as a supporting electrolyte. The idea behind profiling is to treat the obtained data as a whole, and the differences between the samples are very significant. The data obtained in this way is analyzed using machine learning techniques.

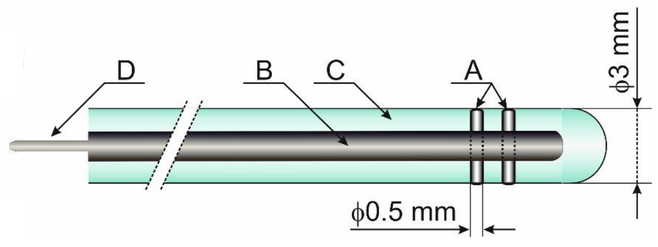

Fig 1. Schematic diagram of the electrode used in the experiments:
(A) iridium wire (f ¼ 0.5 mm), (B) silver rod (f ¼ 2.5 mm), (C) epoxy and (D) electrical contact

Standard procedure of measurment

The profiles of the food samples were recorded using stripping voltammetry, in the differential pulse (DP) technique. Before starting the measurements, a series of optimization experiments were carried out to determine the method of polishing the working electrode surface and the measurement parameters.

As a result of a series of optimization experiments, it was possible to develop a universal procedure for profiling food samples. The optimal measurement window was the range from -1000 to 1000 mV, with a potential step of 2 mV and a potential pulse of 50 mV. The sampling and waiting times are set to 20 ms. Due to the specificity of q-DIrE (Fig 1.), it was necessary to use the electrode activation potential of 2000mV for 1 second.

In order to improve the quality of the obtained results, an automatic measurement procedure was used which carried out the subsequent stages of the experiment in a perfectly repeatable manner. This procedure allowed for the planning of all stages of the experiment and the registration of scans in a strict time regime without operator intervention.

Honey profiling included 12 samples of different honeys collected in one apiary, one region and during one year. Each of the honey was dissolved in distilled water in the proportion of 4 g of honey to 25 ml of water. The samples prepared in this way were used for the experiment (Fig. 2). The collected data was analyzed using the PCA algorithm (Fig. 3).

Coffee profiling included 12 samples of various Arabica coffee infusions from different countries of the world. Each coffee was brewed systematically. The samples prepared in this way were used for the experiment (Fig. 4). The collected data was analyzed using the PCA algorithm (Fig. 5).

Honey

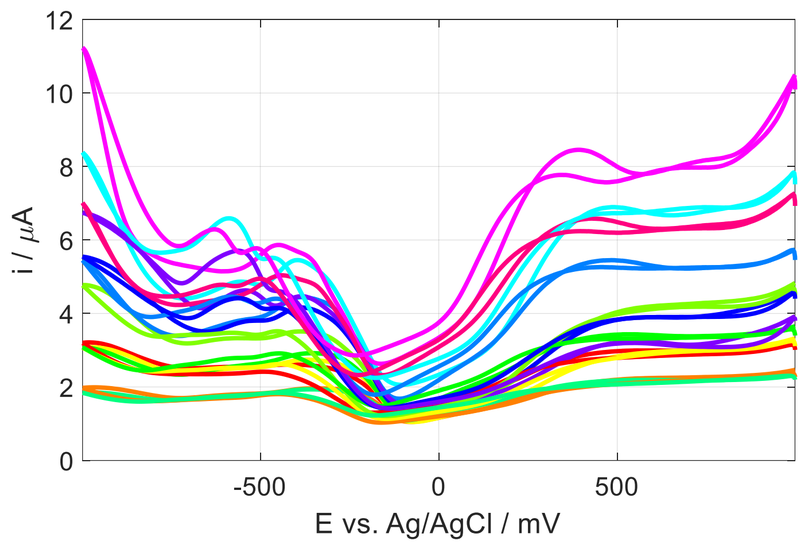

Fig 2. Anodic and cathodic DP Voltammograms of honey.

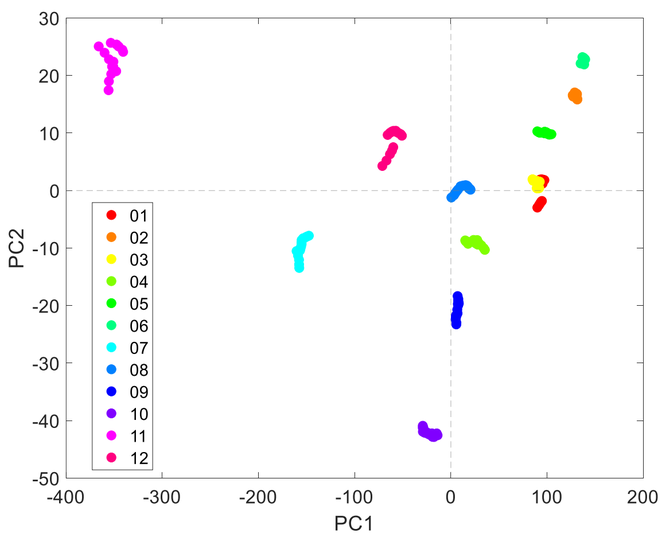

Fig 3. Projection of the objects on the PC1/PC2 plan obtained using anodic scans of honey samples.

Coffee

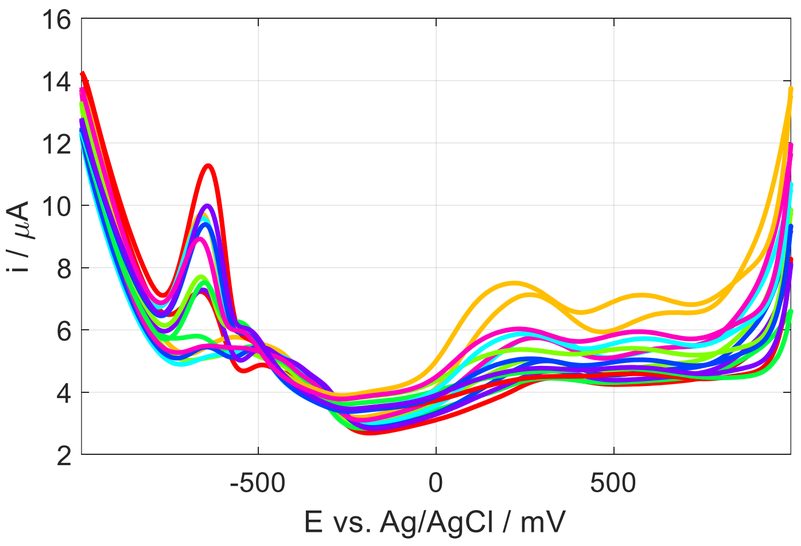

Fig 4. Anodic and cathodic DP Voltammograms of coffee.

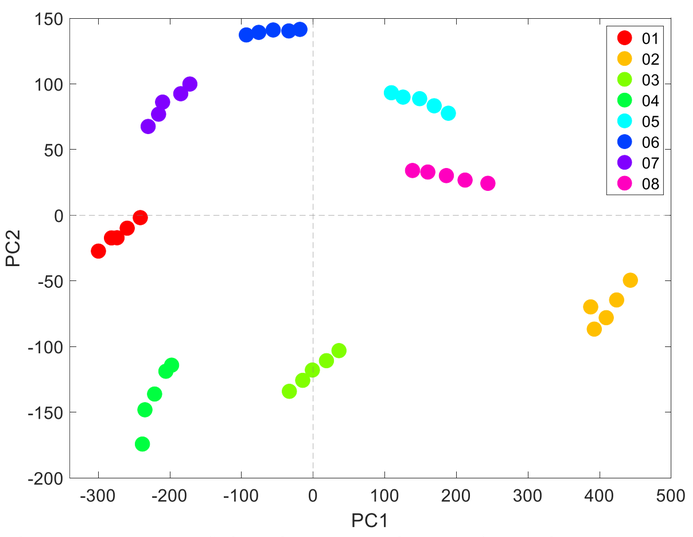

Fig 5. Projection of the objects on the PC1/PC2 plan obtained using anodic scans of coffee samples.

References

[1] Sz. Wójcik, J. Kopeć, B. Baś, M. Jakubowska, A new approach in voltammetric profiling of wines and whiskies based on a useful faradaic signal component, Analytical Methods, 11 (2019) 5984–5996
[2] Sz. Wójcik, M. Jakubowska, Deep neural networks in profiling of apple juice adulteration based on voltammetric signal of the iridium quadruple-disk electrode, Chemometrics and Intelligent Laboratory Systems, 209 (2021) 1-10
[3] Sz. Wójcik, Ł. Górski, M. Jakubowska, Observation of spontaneous maturation process of young wine by application of the voltammetric quadruple disk iridium sensor combined with chemometrics, Journal of the Electrochemical Society, 168 (2021) 1-9
[4] Sz. Wójcik, J. Wyrwa, M. Dziubaniuk, M. Jakubowska, Unconventional solid-like picein wax carbon paste electrode in europium determination, Ionics, 26 (2020) 2643 – 2653
[5] I. T. Hováth, P. T. Anastas, Innovations and Green Chemistry, Chemical Reviews, 107 (2007) 2169 - 2173