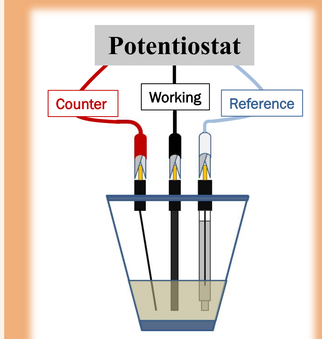
Analysis of Beverage Antioxidants by PEDOT-Based Sensor

Hande Karaosmanoglu, Jadranka Travas-Sejdic and Paul Kilmartin
School of Chemical Sciences, University of Auckland, New Zealand

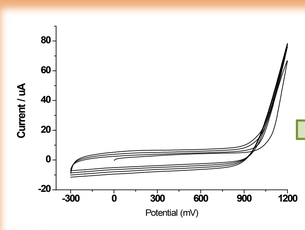
Introduction

The antioxidants are important in terms of human health and food quality. Tea and coffee are the most frequently consumed beverages rich in antioxidants. The most commonly used antioxidant determination methods are the Folin-Ciocalteu and HPLC analyses[1]. However, these methods have various disadvantages such as long time requirement, low sensitivit, interfering agents etc. Recently, there has been an increase in research using cyclic voltammetry (CV) in the antioxidant determinations. In addition to glassy carbon electrodes, conducting polymers such as polypyrole[2], poly(3,4-ethylene dioxithiophene) (PEDOT)[3] and polythiophene[4] have been used in order to improve sensitivity and specificity. In this study, PEDOT-covered sensors were used for rapid and selective antioxidant analyses of coffee and tea samples.

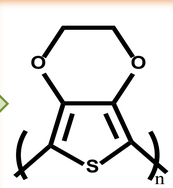
Material & Method



- Glassy carbon electrode (GCE, 1mm dia.) was covered with PEDOT film by cycling in 0.1M EDOT/ 0.1 $LiClO_4$ in propylene carbonate at 100mVs^{-1}.
- Diluted samples (green, black teas and coffees) and phenolic compound solutions were tested by CV between -400 and 800 mV (Ag/Ag^{+}) at 100mVs^{-1}.
- The voltammograms were obtained after subtraction of the background PEDOT curves.
- A 3mm diameter bare glassy carbon electrode was used to make comparisons since it has been used in previous studies.
- HPLC analyses were performed to identify and quantify the polyphenol contents of the beverages.
- In addition, the Folin-Ciocalteu assay was carried out to determine Total Phenolic Content (TPC).

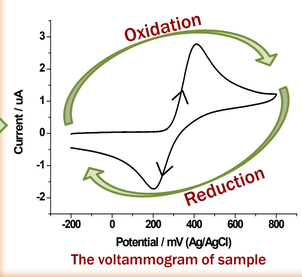


The voltammogram of polymerization



PEDOT

PEDOT-covered 1mm dia. Glassy Carbon Electrode



The voltammogram of sample

Results

- During a CV, the antioxidants present in tea and coffee samples were oxidized and reduced. The obtained CV was the sum of the various compounds.
- The CV of green tea (pH 5.5) resembled that of EGCG (pH 5.5), while the CV of coffee (pH 5.5) was similar to that of chlorogenic acid (pH 5.5). HPLC analysis of beverages showed that the major phenolic compound of green tea and coffee are EGCG and chlorogenic acid, respectively. (Figure 1.)
- The results obtained with PEDOT sensor are consistent with those obtained from a 3mm dia. bare glassy carbon electrode.

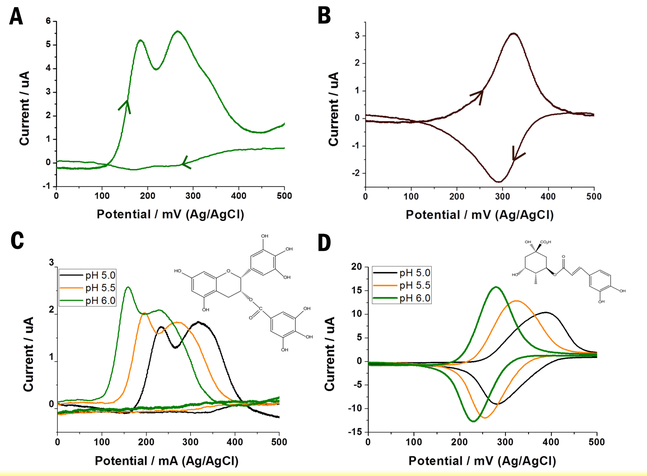


Figure 1: The CVs of 5-fold diluted green tea (pH5.5) and 20-fold diluted coffee (pH5.5) are shown in A and B , respectively. The CVs of Epigallocatechin gallate (0.05mM) and Chlorogenic acid (1.4mM) in pH 5, 5.5 and 6 phosphate buffers are shown in C and D, respectively.

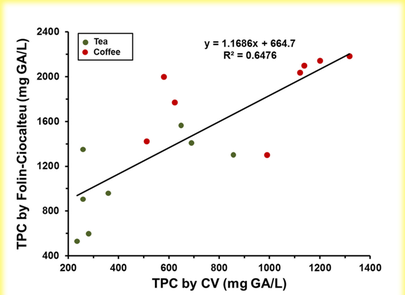


Figure 2: Comparison of the TPC values obtained by CV and Folin-Ciocalteu methods

- The integral of the current vs. time to 500mV (Q_{500}) was calculated. The correlation between the Folin-Ciocalteu and Q_{500} values was found to be 0.65 (Figure 2).

Conclusion

- ✓ The presence of PEDOT enabled a ***smaller*** sensor surface area to be used. The PEDOT-covered 1 mm dia. GCE gave well defined peaks compared to bare GCE.
- ✓ The obtained sensor is ***easier*** to handle and gives ***rapid*** results.
- ✓ The findings showed that it is possible to use this sensor in the quantification and identification of the antioxidant compounds in beverages.

Future work

- ✓ Enzyme immobilization can be tried to develop more sensitive and selective systems. The developed sensor system can be fitted into a device to make it useful for research and industrial applications.

References
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