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ELECTROCHEMICAL CHARACTERIZATION OF GALLIC ACID

Department of Chemistry

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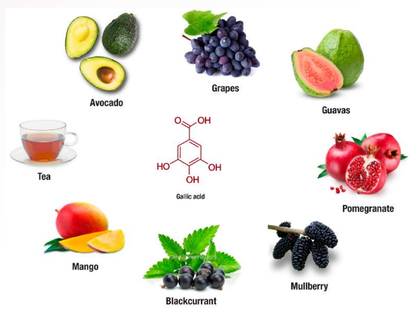
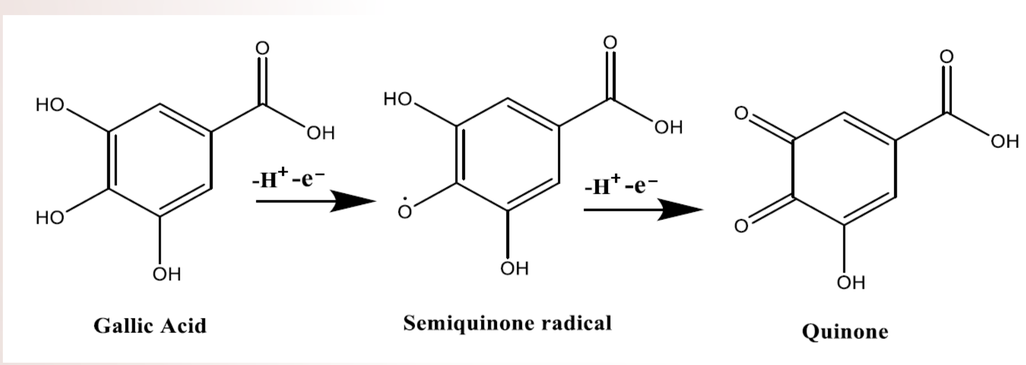
INTRODUCTION

Gallic acid (3,4,5-trihydroxybenzoic acid) is a polyphenol, known for strong anticancer, antioxidant, anti-inflammatory and antimutagenic properties. Additional advantage of selective cytotoxicity for cancerous cells, makes gallic acid important additive in food to prevent cancer risks. It can be abudantly found, in different plants and foodstuff, especially in honey, gallnuts, mango, oak bark and pomegranate. The main goal of this study was to detect gallic acid in model systems and real samples (tea, liquer and wine) with differential pulse voltammetry.



Oxidation mechanism of gallic acid

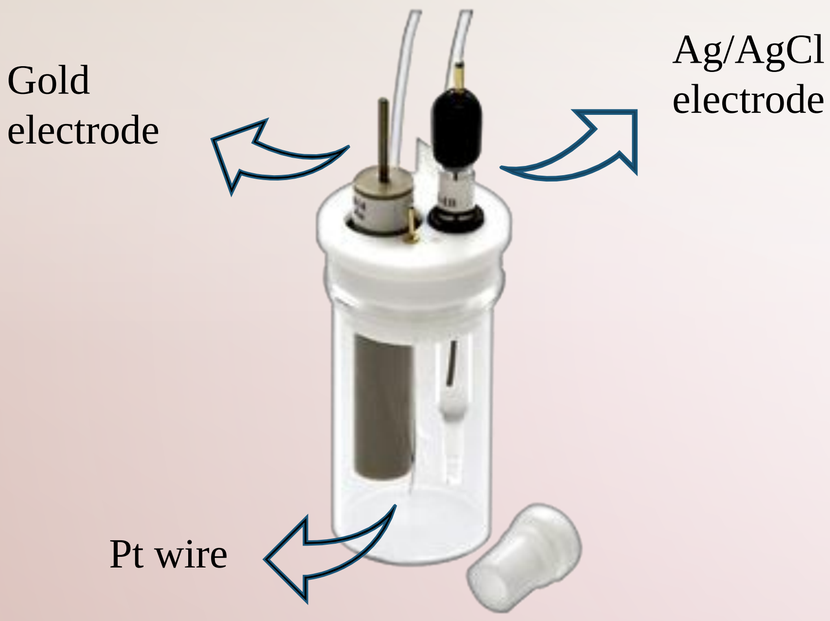


MATERIALS AND METHODS

- Electrochemical measurements were conducted in a three electrode voltammetric cell :

1. WORKING ELECTRODE: Au, Pt, glassy carbon (GC)
2. REFERENCE ELECTRODE: Ag/AgCl electrode
3. COUNTER ELECTRODE: platinum wire

- The system was purged with high purity argon, Ar5 (ϕ_{Ar} = 99.999 %) before each measurement.
- Electrolyte: NaH_2PO_4 (I_c = 0.1 mol dm^{-3})



RESULTS

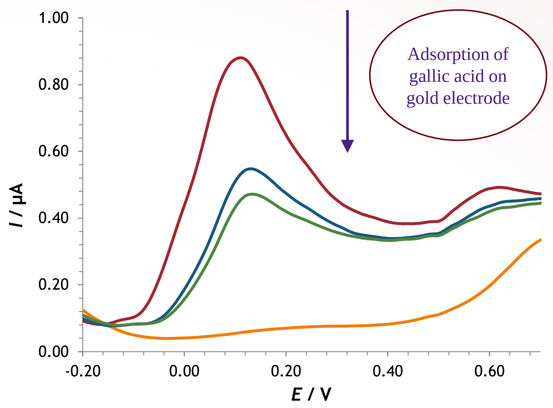


Fig. 1. Differential pulse voltamograms of gallic acid (c = 1 x 10^{-3} mol dm^{-3}) in NaH_2PO_4 (I_c= 0,1 mol dm^{-3}):1st scan (—), 2nd scan (—) and 3rd scan (—). blank solution (—) NaH_2PO_4 (I_c= 0,1 mol dm^{-3}).

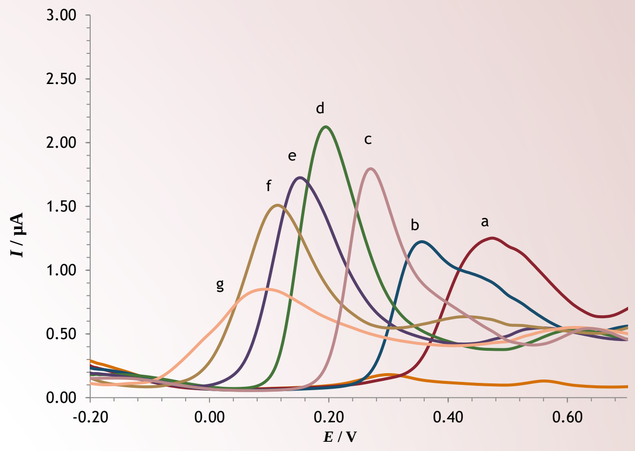


Fig. 2. Differential pulse voltamograms of gallic acid (c = 1 x 10^{-3} mol dm^{-3}) in NaH_2PO_4 (I_c= 0,1 mol dm^{-3}) recorded at gold electrode as a function of pH (pH = (a) 3.0; (b) 4.0; (c) 5.0; (d) 6.0; (e) 7.0; (f) 8.0 and (g) 9.5).

Table 1. Values of peak potential (E_p) and peak current (I_p) of the first oxidation peak of gallic acid (c = 1 x 10^{-3} mol dm^{-3}) as a function of pH.

pH	E_p / V	I_p / µA
3.0	0.452	1.240
4.0	0.347	1.207
5.0	0.264	1.780
6.0	0.189	2.110
7.0	0.145	1.706
8.0	0.107	1.488
9.5	0.069	0.832

Table 2. Comparrison of E_p and I_p values of gallic acid obtained with different working electrodes (gold (Au), platinum (Pt) and glassy carbon (GC)).

Woking electrode	E_p / V	I_p / µA
Pt	0.336	0.920
Au	0.187	1.749
GC	0.211	1.043

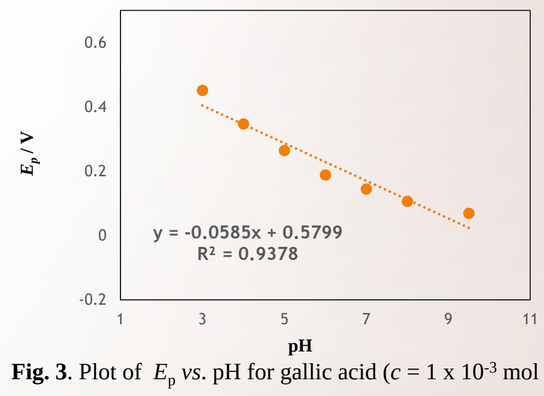


Fig. 3. Plot of E_p *vs.* pH for gallic acid (c = 1 x 10^{-3} mol dm^{-3}).
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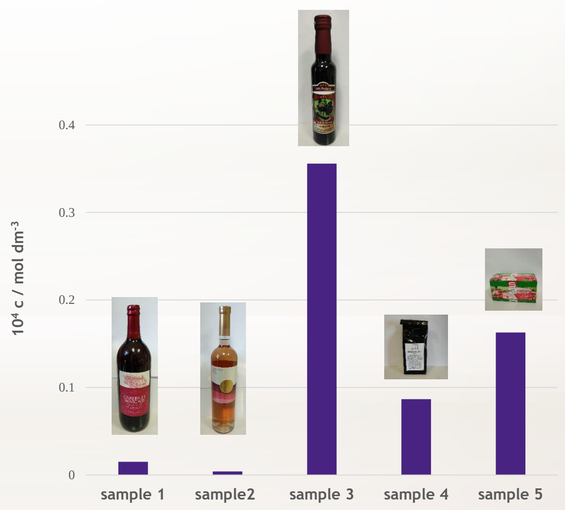

Fig. 5. Column graphs showing concentration of gallic acid in real samples.

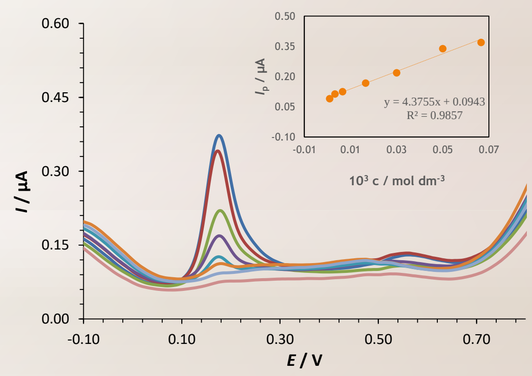

Fig. 4. Differential pulse voltammograms of gallic acid (c = 1 -67 µmol dm^{-3}) in NaH_2PO_4 (I_c= 0,1 mol dm^{-3}) recorded at scan rate 5 mV/s. Inset: calibration curve for determination of gallic acid.

CONCLUSIONS

- Two oxidation peaks of gallic acid were detected as well as adsorption of gallic acid oxidation product (quinone) on the gold electrode surface, oxidation of gallic acid was the most pronounced with Au working electrode
- The highest peak current of gallic acid was obtained around pH 6 while it decreased in more acidic and alkaline media, E_p *vs.* pH plot showed linearity with the slope 58.5 mV
- Gallic acid was detected in model systems and the linear response was obtained in the concentration range from 1 µM to 67 µM, it was also detected in real samples where its quantity varied from 0.4 µM till 36 µM