Stabilitätspakt für Südosteuropa
Gefördert durch Deutschland
Stability Pact for South Eastern Europe
Sponsored by Germany

Determination of antioxidant capacity with a cyclic voltammetry in production step in a double fermentation process during the preparation of traditional home made fruit vinegar

Marija Atanasova[a], Maja Janchovska[a], Galaba Naumova[a], Elizabeta Jancovska[b], Mirjana Bocevska[b], Valentin Mirceski[c]
[a]Faculty of Medical Sciences, University "Goce Delčev", Krste Misirkov bb, 2000 Štip, Macedonia
[b]Faculty of Technology and Metallurgy, Ss. Cyril and Methodius University in Skopje, Rudjer Boskovic 16, 1000 Skopje, Macedonia
[c]Institute of Chemistry, Faculty of Natural Sciences and Mathematics, Ss Cyril and Methodius University, PO Box 162, 1000, Skopje, Macedonia

Introduction

Cyclic voltammetry experiments offer the opportunity to obtain more data from an experiment. Cyclic voltammetry is the most frequently employed technique for the investigation of total antioxidant capacity in different samples. Vinegar natural antioxidants are believed to be effective compounds in the prevention of oxidative stress related diseases. Protective effects of antioxidants are mainly attributed to their ability to scavenge reactive free radical species.

Vinegar may include caffeic acid, citric acid, ferulic acid, gluconic acid, succinic acid, tartaric acid, cyanidin, tyrosol and various other phenolics, flavonoids and anthocyanins.

Six fruit vinegars were manufactured through alcoholic and subsequent acetic fermentation followed by conversion of sugars through alcohol into a acetic acid. The fermentation was made without yeast fermentation and without addition of acetic acid bacteria. Nine samples of commercial fruit vinegars which are available in Macedonia were used to compare the quality. The fruits which were used to manufacture the vinegars contained high level of antioxidant compounds.

Materials and Methods

Materials:

- 6 homemade fruit vinegars (apple, raspberry, blueberry, bramble, rose hip and persimmon)
- 9 commercial vinegars

Methods:

- Cyclic voltammograms were recorded on potentiostat PalmSens connected to the PC
- Potential range : E_{start} = -0.1 V, E_{end} = 0.9 V, Scan rate of 10 mV/s, E_{step} = 0.001 V .The three electrodes were immersed into a 5 ml electrochemical cell, containing 4,5 ml vinegar, 0,5 ml KCl, 50µl ABTS (10^{-4} mol/l)

Firstly there was made characterization of ABTS (Fig 2). The results have shown that optimal scan rate for this experiment is 10 mV/s (Fig. 1)

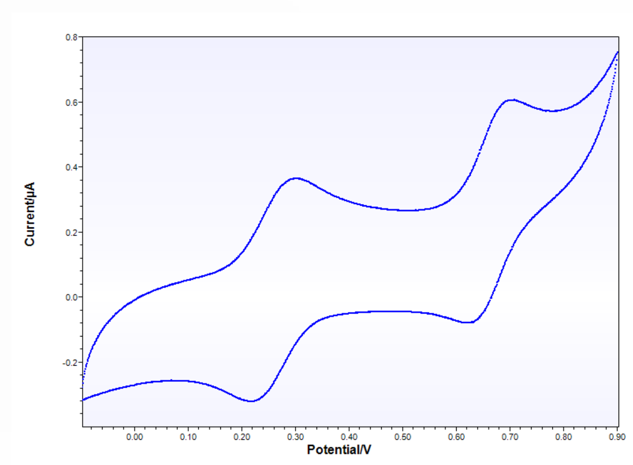

Fig.1 Cyclic voltammogram of 0.1 mmol/l ABTS and 0.1 mol/l KCl at 10 mV/s

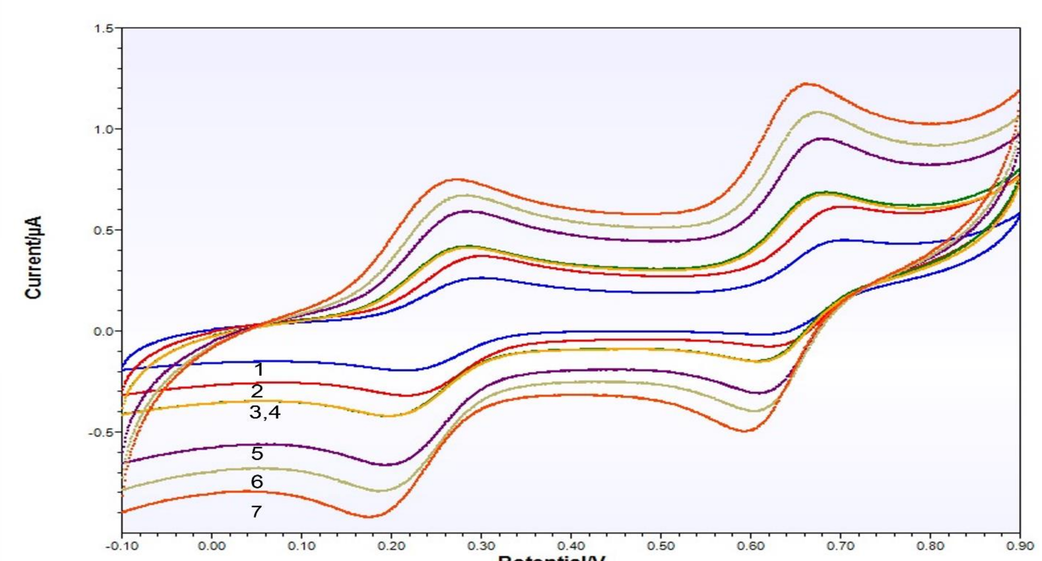

Fig.2 Cyclic voltammogram for characterization of ABTS 0.1 mmol/l ABTS and 0.1 mol/l KCl
Scan rate (1) v = 5 mV/s (2) v = 10 mV/s (3) v = 15 mV/s (4) v = 20 mV/s (5) v = 30 mV/s (6) v = 40 mV/s (7) v = 50 mV/s

Result and discussion

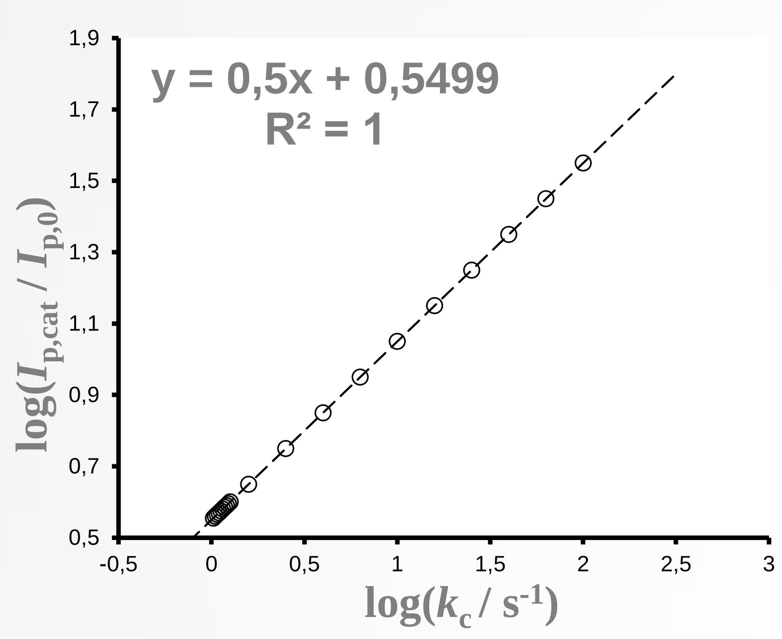

Fig.3 Calibration curve

First calibration was performed with four referent substances (ascorbic acid, trolox, γ-glutamyl-cysteinyl-glycine (GSH) and Gallic acid), but the given results did not show good correlation because of the background reactions. That is why calibration was made with theoretically simulated calibration curve (the electrode reaction showed reversibility (I_{ox}/I_{red} ≅ 1; ΔEp = 66,8 mV ± 3.6 mV)), and total antioxidative capacity was expressed as value of rate constant of electrode reaction, kc instead of equivalents of some referent substance. The value of rate constant of electrode reaction, kc is directly proportional $v = k_c' \times c_o \times c_x \Rightarrow k_c' \times c_x = k_c$ (s^{-1}) to the concentration of polyphenols (total antioxidative capacity).

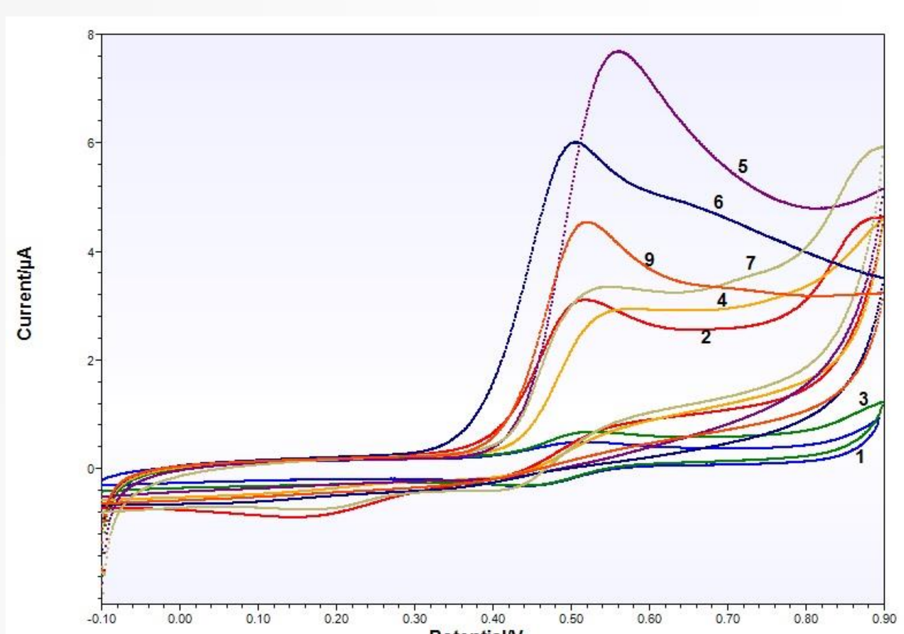

Fig.4 Cyclic voltammogram of commercial vinegars at 10 mV/s

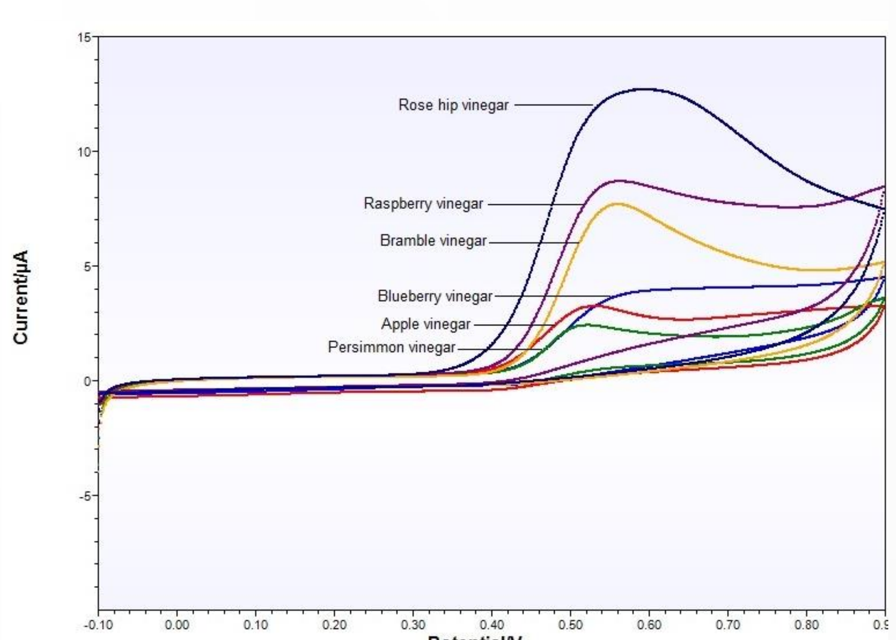

Fig.5 Cyclic voltammogram of homemade fruit vinegars at 10 mV/s

Mainly, rose hip, bramble and raspberry homemade vinegar samples had the highest antioxidant capacity (148.08 s^{-1}, 58.71 s^{-1}, 54.35 s^{-1}, respectively), on the other hand apple, persimmon and blueberry vinegar samples had significantly lower antioxidant capacity (5.53 s^{-1}, 3.89 s^{-1}, 9.54 s^{-1}, respectively) (Fig.5, 6). Also, commercial apple vinegar samples (1,2 and 3) had lower antioxidant capacity (1.24 s^{-1}, 0.14 s^{-1}, 3.74 s^{-1}, respectively) than homemade apple vinegar sample (5.53 s^{-1}). (Fig.4,7)

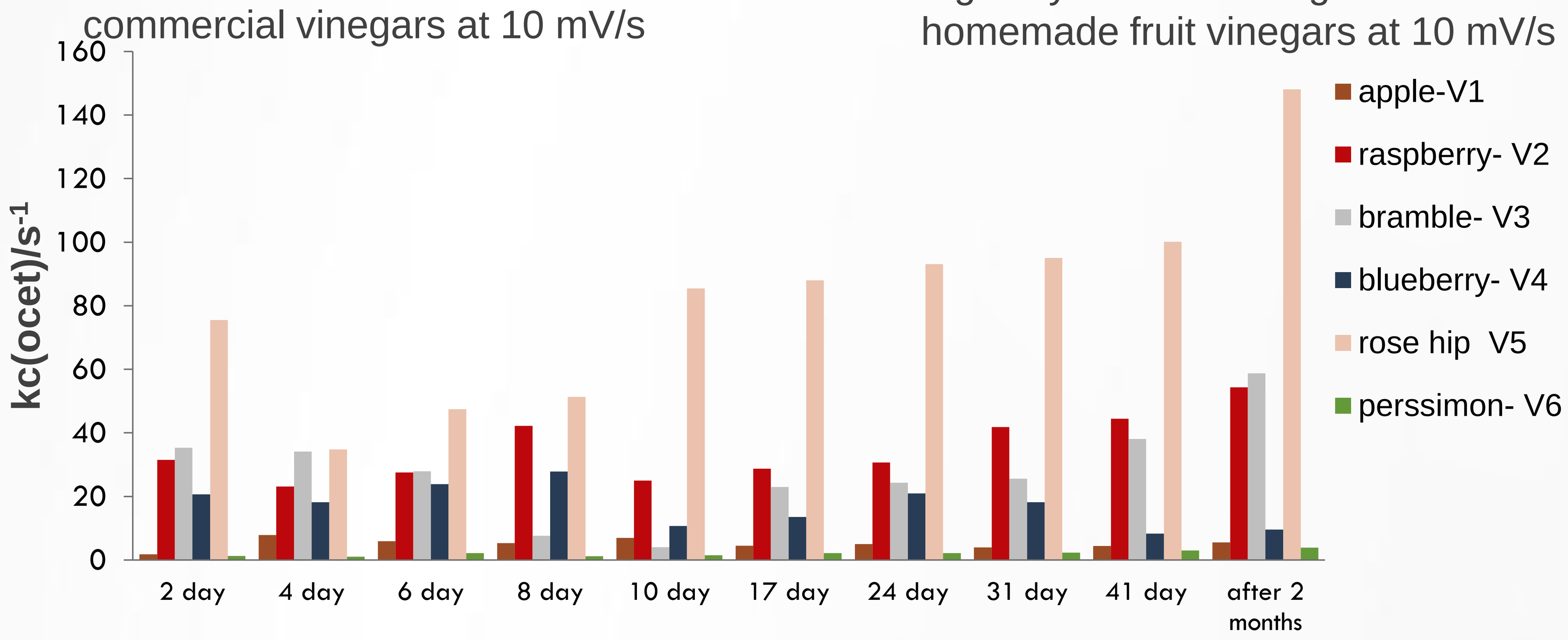

Fig.6 Evolution of antioxidant capacity parameters of homemade fruit vinegar in the production step

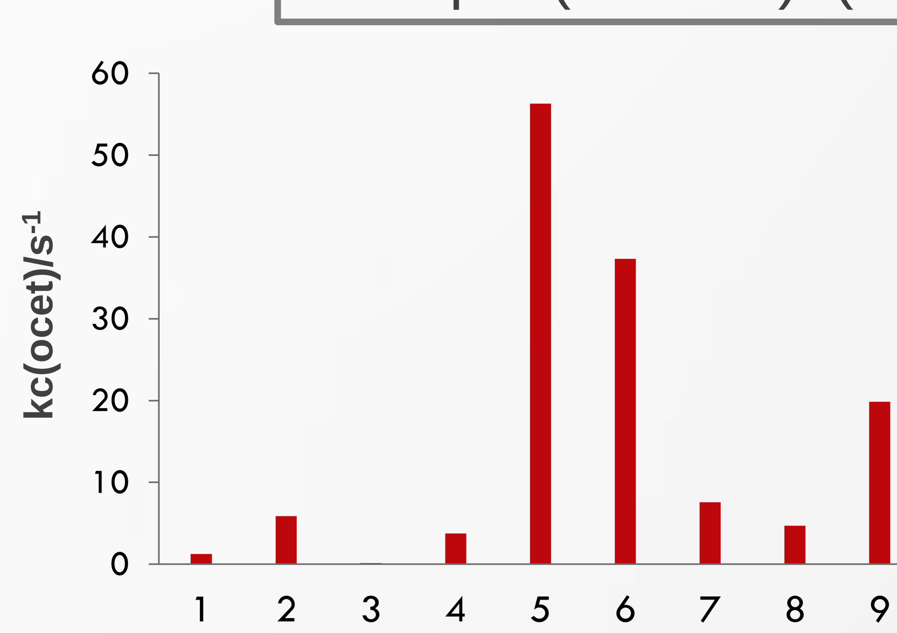

Fig.7 Evolution of antioxidant capacity parameters of commercial vinegars

Conclusion

Strong positive correlation was established between antioxidant activities deduced from cyclic voltammograms with those determined using spectrophotometric assays, (DPPH, ABTS, TPC, b-carotene assays) which were also performed.