Two-Step Chronoamperometric Determination of Antioxidant Capacity of Water Extracts from Medicinal Plants

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Since ancient times, medicinal plants have been used for the treatment of human diseases. The wide range of bioactive compounds contained in plants stipulates the development of new phytopharmaceuticals. Traditional phytotherapy is also still applied as part of complex treatment. Antioxidants are one of the largest groups of bioactive compounds of plant origin that are widely distributed in medicinal plants. Thus, the evaluation of the antioxidant capacity of medicinal plant extracts used in phytotherapy is of practical interest.

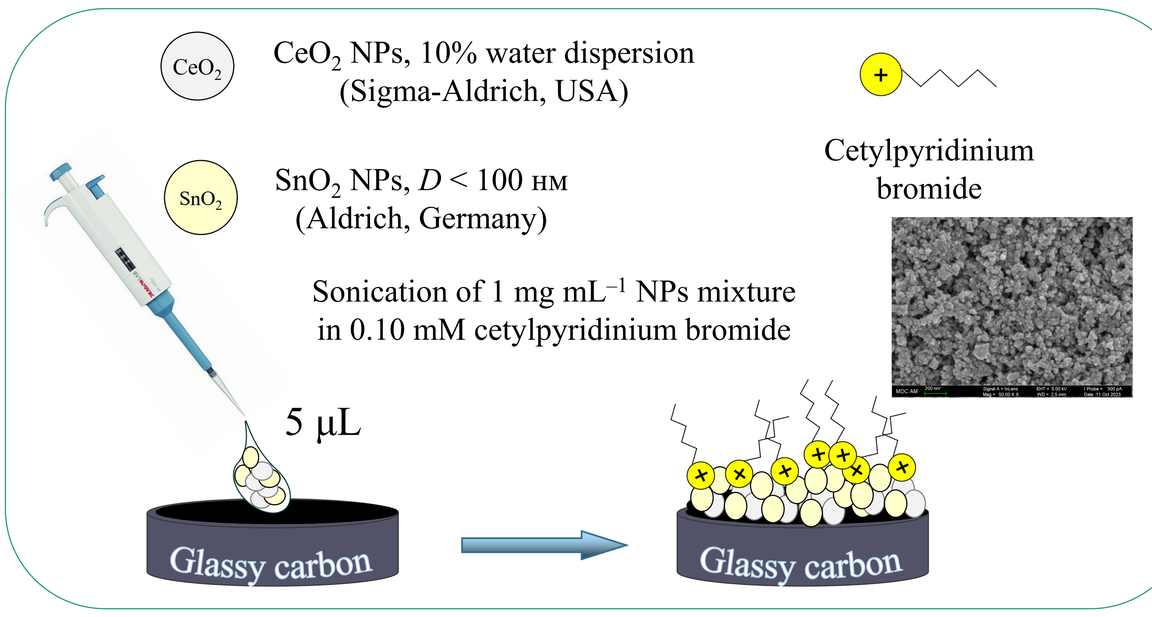
Electrochemical methods have been shown to be a highly effective tool for the evaluation of total antioxidant parameters of plant materials. They combine high precision, cost-efficiency, rapid response, simplicity, and in-field applicability. In application to medicinal plants, the electrochemical response usually corresponds to the contents of several antioxidants of similar structure. The current work is focused on the development of a novel chronoamperometric method for the determination of the antioxidant capacity of water extracts from medicinal plants obtained by sonication using glassy carbon electrode (GCE) modified with a mixture of CeO_2 and SnO_2 nanoparticles (NPs) dispersed in cetylpyridinium bromide.

Plant material and extract preparation

Plant material	Plant : solvent ratio
Alni fructus	1:10
Quercus cortex	1:10
Frangulae cortex	1:10
Potentillae rhizomata	1:10
Bergeniae rhizomata	1:10
Sanguisorbae rhizomata et radices	1:10
Leonuri herba	1:10
Tiliae flores	1:20
Salviae folia	1:10
Urticae folia	1:33
Chamomillae flores	1:33

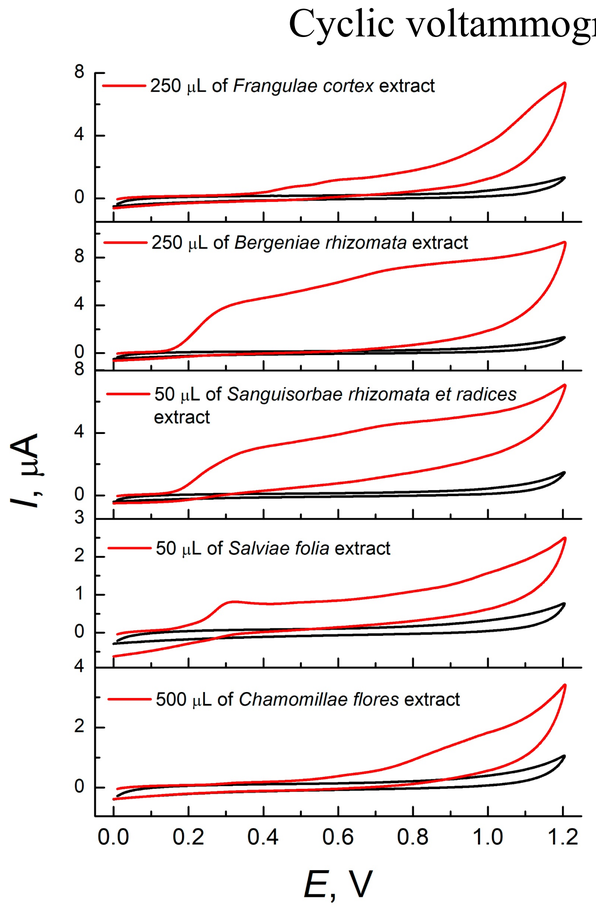
Sonication for 30 min

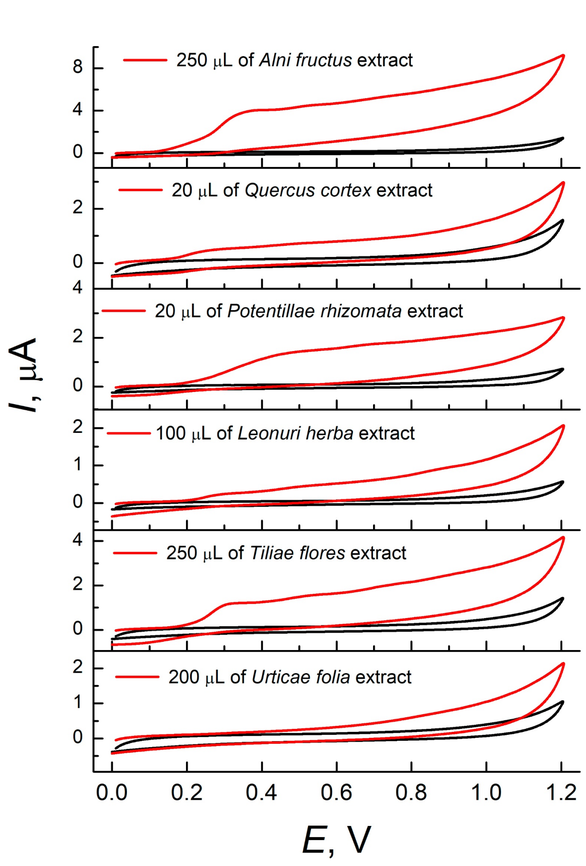
Electrode surface modification



VOLTAMMETRIC CHARACTERISTICS OF MEDICINAL PLANT EXTRACTS

Cyclic voltammograms at the bare GCE





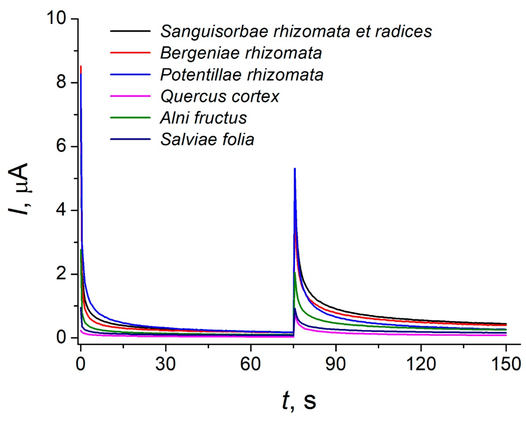
Voltammetric characteristics of water extracts from medicinal plants on the bare and modified GCE in phosphate buffer pH 7.0 (n = 5; P = 0.95).

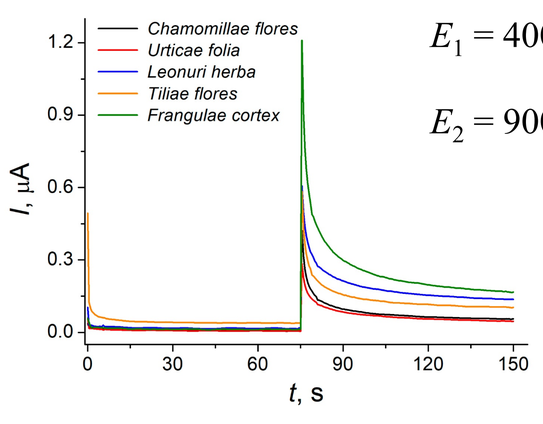
Medicinal plant material	Bare GCE			GCE modified with CeO_2 and SnO_2 NPs		
	V_{al}, μL	E_{ox}, V	I, μA	V_{al}, μL	E_{ox}, V	I, μA
Alni fructus	250	0.34; 0.52	0.97±0.08; 0.070±0.005	50	0.33, 0.52	0.26±0.04; 0.025±0.002
Quercus cortex	20	0.25; 0.50	0.11±0.04; 0.014±0.002	20	0.34	0.18±0.02
Frangulae cortex	250	0.47; 0.59	0.060±0.03; 0.076±0.002	500	0.44, 0.61	0.28±0.04; 0.16±0.01
Potentillae rhizomata	20	0.43; 0.68	0.26±0.02; 0.032±0.001	20	0.32	0.84±0.06
Bergeniae rhizomata	250	0.29; 0.76	1.4±0.09; 0.41±0.03	100	0.32, 0.74	1.1±0.1; 0.044±0.008
Sanguisorbae rhizomata et radices	50	0.33; 0.72	0.87±0.07; 0.14±0.02	20	0.35, 0.74	0.60±0.01; 0.017±0.001
Leonuri herba	100	0.29; 0.51; 0.87	0.053±0.001; 0.017±0.002; 0.009±0.002	100	0.31, 0.53	0.011±0.002; 0.018±0.002
Tiliae flores	250	0.30; 0.52; 0.75	0.40±0.05; 0.051±0.005, 0.025±0.003	250	0.39, 0.76	0.45±0.02; 0.017±0.001
Salviae folia	50	0.31	0.45±0.02	50	0.34	0.59±0.04
Urticae folia	250	—	—	500	0.90	0.016±0.003
Chamomillae flores	500	0.32; 0.97	0.017±0.02; 0.015±0.002	500	0.32	0.023±0.002

CHRONOAMPEROMETRY OF WATER EXTRACTS FROM MEDICINAL PLANTS

Antioxidant capacity (AOC) of water extracts from medicinal plants (n = 5; P = 0.95)

Two-step background subtracted chronoamperograms of 50 μL of medicinal plant extracts





E_1 = 400 mV

E_2 = 900 mV

Medicinal plant material	AOC_{400}, μA per 100 mL	RSD, %	AOC_{900}, μA per 100 mL	RSD, %
Alni fructus	747±57	3.1	2053±81	3.2
Quercus cortex	938±51	2.2	1860±86	1.9
Frangulae cortex	80.0±0.9	0.88	1320±99	3.0
Potentillae rhizomata	1404±101	2.9	2204±101	1.8
Bergeniae rhizomata	1360±52	2.4	2840±99	1.4
Sanguisorbae rhizomata et radices	1347±57	1.7	3400±99	1.2
Leonuri herba	112±5	2.9	1073±40	1.5
Tiliae flores	297±18	3.9	832±45	3.4
Salviae folia	518±37	5.7	1104±60	2.2
Urticae folia	33±2	5.5	325±10	1.3
Chamomillae flores	43±3	6.8	403±23	2.3

Conclusions

The results obtained confirm the accuracy of the developed chronoamperometric method (strong (r = 0.7–0.9) and very strong (r = 0.9–1.0) correlation with total phenolic contents and antioxidant capacity toward DPPH$^{\bullet}$). Furthermore, the method developed is simple and does not require the application of additional specific reagents such as the Folin-Ciocalteu reagent or DPPH$^{\bullet}$ which is unstable and highly affected by the presence of light and water. The use of phosphate buffer pH 7.0 is close to the physiological conditions making possible partial prediction of medicinal plants effect in the biosystems. Another advantage of chronoamperometry is a rapid response due to the absence of an incubation stage that makes the method applicable for fast screening tests. The use of two potentials for the electrolysis allows discrimination of the antioxidants by power.