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**STUDY OF ANTIOXIDATIVE ACTIVITY OF EXTRACTS
FROM WASTES OF CARBON DIOXIDE EXTRACTION
OF *SCABIOSA OCHROLEUCA* L.
BY WAY OF INVERSE VOLTAMMETRY**

Abstract. We have studied the antioxidative activity (AOA) of water and alcoholic extracts from waste of carbon dioxide extraction of top part of cream scabious (*Scabiosa ochroleuca* L.). Study of AOA of water and alcoholic extract from waste of carbon dioxide extraction of herb of cream scabious was made by way of inverse voltammetry. Using the method of cathode voltammetry to carry out one experiment, the sample of extract of 0,3 g was taken. The direct current mode of cathode voltammetry was applied, scanning velocity $W = 40$ mV/s, operational range of potentials 0,0 to -1 V. Electrochemical cell was represented by glass bowl with solution of bulk electrolyte with immersed indicative mercury-film electrode, chloride-silver reference electrode and chloride-silver electrode. As the base solution – phosphate buffer with pH 6,6. Ratio of change of current of EV O₂ was the indicator of activity of sample under study. Water and alcoholic extracts from waste of carbon dioxide extraction (CO₂-residues) was obtained by infusion in ethyl alcohol of 70% and distilled water; for this 350 g of air-dry weight of CO₂-residues of cream scabious was taken and put to the container of stainless steel. Ethyl alcohol of 70% / distilled water was added, and infused for 3 days. After this, it was filtered to round-bottom flask with slice (250 ml) and distilled the solvent with rotary evaporator. *Extracts concentration* from waste of carbon dioxide extraction was carried out with rotary evaporator IKARV 10 Digital with temperature range of 40-45 °C, on the base of Scientific and research institute «Novye materialy» of Karaganda State Technical University.

Keywords: *Scabiosa ochroleuca* L., inverse voltammetry, antioxidative activity, kinetic criterion, waste of carbon dioxide extraction, biologically active substances.

Introduction. To estimate the antioxidative activity (AOA), there are generally accepted criteria. New method for AOA estimation, developed by researcher Korotkova Ye.I. and co. (2009), named «*kinetic criterion*», allows to define the AOA of sum of biologically active substances (BAS) of vegetable origin. *Kinetic criterion* reflects the amount of oxygen and reactive oxygen intermediates, responded to total antioxidant capacity in the extract [1].

Total antioxidative activity is defined by decrease of model signal in presence of all the components, major, known and minor. Method has good sensitivity (10⁻⁵-10⁻⁷g/l) and allows to define the total antioxidative activity basing upon electrochemical reduction of oxygen in absence and presence of antioxidant of vegetable nature, with cumulation of active forms of oxygen on the surface of electrode. Oxygen takes electron from the electrode and forms superoxide that immediately responds to proton, and due to this more stable active oxygen radical

is formed. In the third stage active oxygen radical responds to proton, forming the hydrogen peroxide, which is chemically unstable and turns to water at surplus of oxygen [2, 3].

EXPERIMENTAL PART

Carbon dioxide extraction of *Scabiosa ochroleuca* L. was carried out using air-dry raw material (cut-up aerial parts of plants) at $T=291-294$ K and pressure in $P=69.76$ atm., during 16-18 hours; the process were performed on the technical equipment «JUPE» produced by the manufacturing company «Phyto-Aromat» LLP (Almaty, Kazakhstan) (table 1) [4].

Table 1 – Parameters of carbon dioxide extraction process

Type of SMHO (Starting Materials of Herbal Origin)	Mass, G	Number of material	Work pressure, atm.	Temperature, °C	Time, H	Yield, G
<i>S. ochroleuca</i>	2600	1 st	69-72	18-21	18	12
		2 nd	76	22	16	10

Yield for *Scabiosa ochroleuca* L. it is equal to 0,85%.

RESULTS AND DISCUSSION

To estimate the antioxidative activity of water and alcoholic extract from waste of carbon dioxide extraction of cream scabious (*Scabiosa ochroleuca* L.), we prepared three samples of each item:

- a) 0,3 g of water extraction was dissolved in 10 ml of purified water;
- b) 0,3 g of alcoholic extract was dissolved in 10 ml of ethyl alcohol of 70%.

For studied substances current-voltage curves were obtained, presented in accordance with pictures 1-4 for alcoholic extract and pictures 5-7 for water extract.

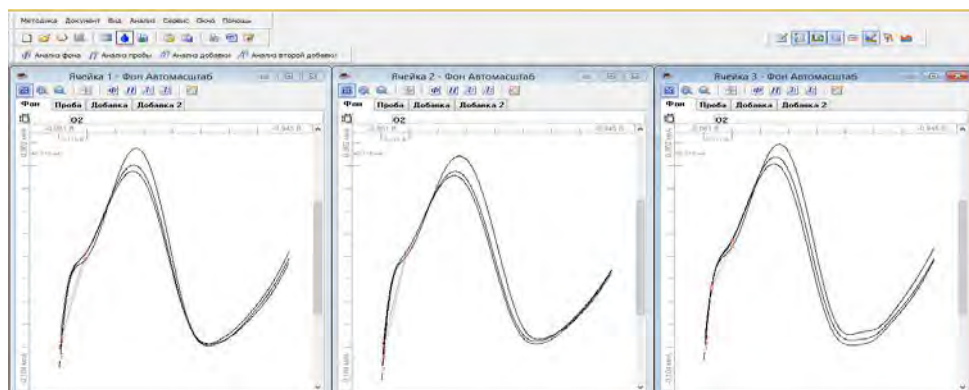


Figure 1 – Current-voltage curve of background

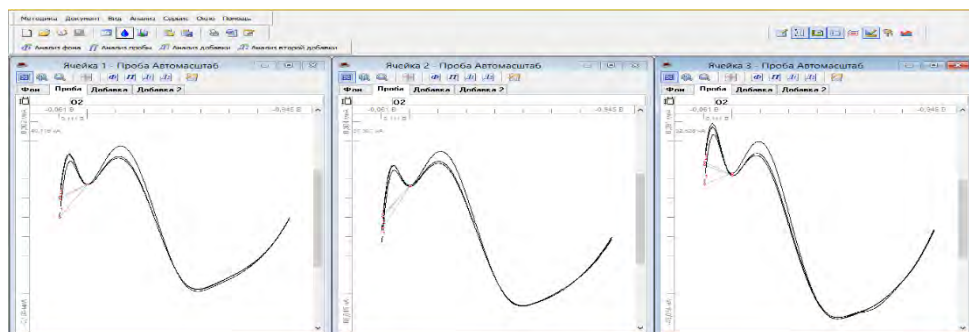


Figure 2 – Current-voltage curve of sample

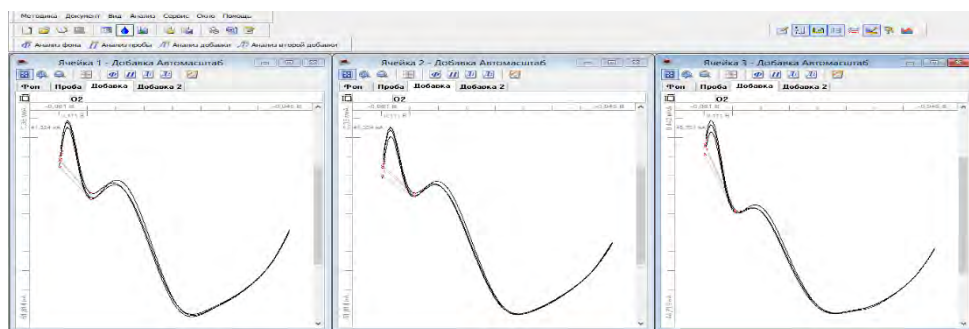


Figure 3 – Current-voltage curve of adding 1

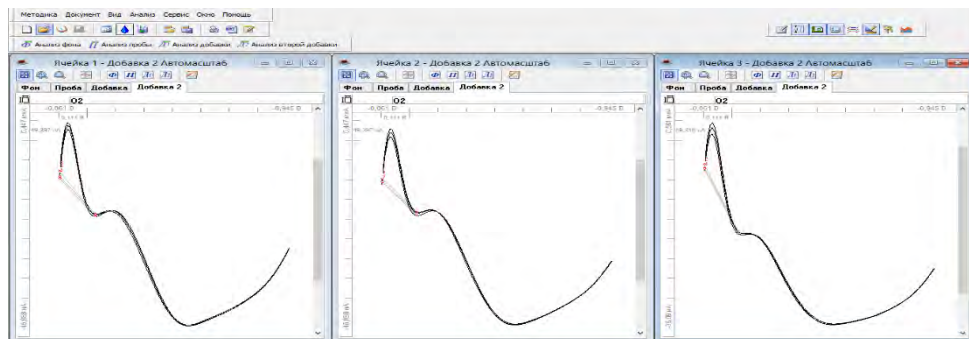


Figure 4 – Current-voltage curve of adding 2

Current-voltage curves of background characterize the background current in absence of extract in the solution, cathode waves of oxygen and hydrogen peroxide are registered [5]. Addition of extract results the decreasing of cathode current of oxygen, depending on the time of reaction between oxygen forms and extract in solution, and step towards positive part of potential.

Table 2 presents the process parameters and results of study of antioxidative activity of alcoholic extract from waste of carbon dioxide extraction of herb of cream scabious.

Table 2 – Process parameters and results of study of antioxidative activity of alcoholic extract from waste of CO₂ extraction of herb of cream scabious

Cell, №	Cell – 1, mcA	Cell – 2, mcA
Sample, №	1	2
Peaks current	I	I
Background	0,035	0,036
Sample	0,047	0,048
1st addition	0,053	0,051
2nd addition	0,086	0,084
Concentration, g/l	0,0003906	0,0003954
	0,000393	

Current-voltage curves of water extract from waste of carbon dioxide extraction of herb of cream scabious are presented in accordance with pictures 5-7.

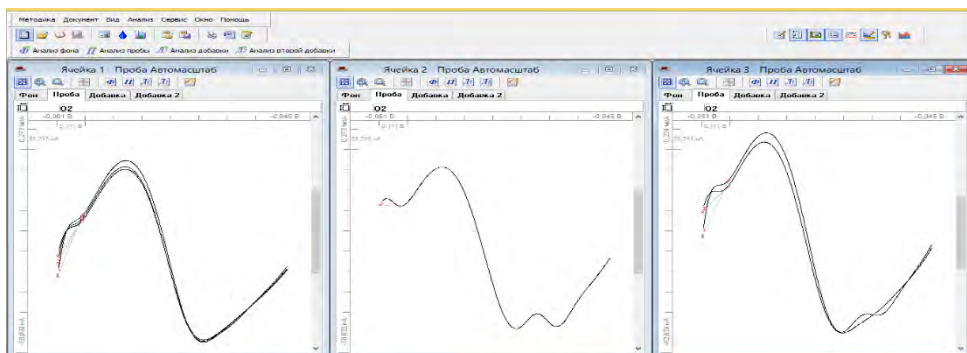


Figure 5 – Current-voltage curve of sample

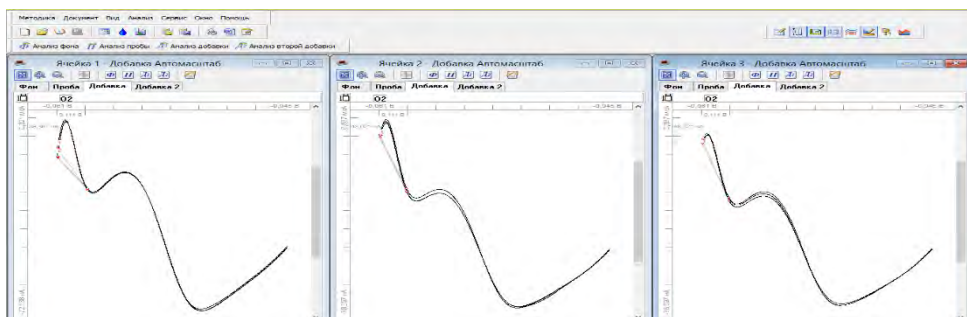


Figure 6 – Current-voltage curve of adding 1

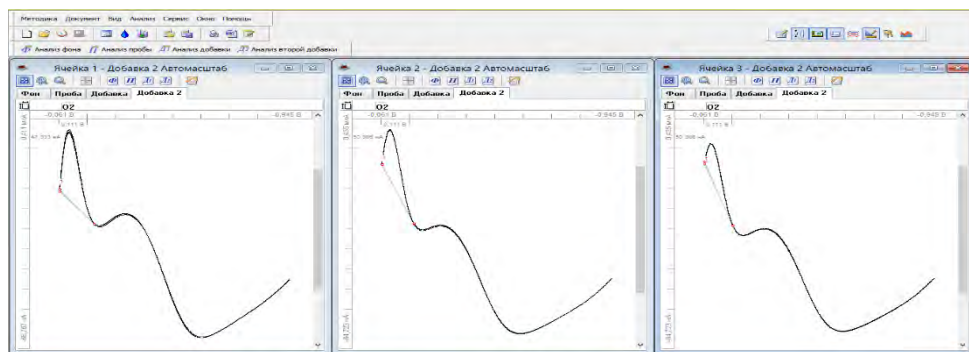


Figure 7 – Current-voltage curve of adding 2

Table 3 presents the process parameters and quantitative information of results of study of water extract from waste of carbon dioxide extraction of herb of cream scabious.

Table 3 – Process parameters and results of study of antioxidative activity of water extract from waste of carbon dioxide extraction of herb of cream scabious

Cell, №	Cell – 1, mcA	Cell – 2, mcA
Sample, №	1	2
Peaks current	I	I
Background	0,003	0,003
Sample	0,027	0,002
1st addition	0,092	0,009
2nd addition	0,160	0,013
Concentration, g/l	0,0003515	0,0003306
	0,00034105	

On the basis of obtained data, we defined the kinetic criterion under the following formula:

$$K = \frac{c_0}{t} \cdot \left(1 - \frac{I}{I_0}\right),$$

where I – limiting current of electroreduction of oxygen in presence of antioxidant in the solution, mcA, I_0 – limiting current of electroreduction of oxygen in absence of antioxidant in the solution, mcA, C_0 – initial concentration of oxygen in the solution, mmole/l (equal to the solubility of oxygen in studied electrolyte at normal conditions), t – period of exposure of generator electrode at constant potential of limiting current of the oxygen, characterizing the reaction of interaction of oxygen with active oxygen radicals, min [1].

Results of definition of AOA of studied extracts are shown in table 4.

Table 4 – Results of estimation of AOA of water and alcoholic extract from waste of carbon dioxide extraction of herb of cream scabious

№	Base solution	Antioxydant	Kinetic criterion, $\mu\text{mole/l}\cdot\text{min}$	Operating range of potentials, B	C_0 , g/mole	t , min
1	Phosphate buffer, pH 6.6	Alcoholic extract	0.0008	-0.061 ÷ -0.945	0,01	3
2		Water extract	0.003			

Numerical indicators of kinetic criteria confirm the influence of number of factors, such as nature of solvent applied at extraction of components from vegetable raw materials, compatibility of components in obtained extracts subject to antioxidative capacities of objects [1].

The study of influence of water and alcoholic extract from waste of carbon dioxide extraction of cream scabious on the process electroreduction of oxygen was carried out. As a method of estimation, cathode voltammetry with mercury film electrode was applied. In this approach definition of antioxidative activity reflected the quantity of active forms of oxygen, neutralized with antioxidant in definite time. Decrease of cathode current $EV O_2$ was observed, that certifies the expression of antioxidative activity related to this process. Besides, potential shift of cathode current $EV O_2$ to the positive part of potentials was observed. All the above mentioned supposes the presence of ES mechanism (electrochemical and chemical stages), that includes the following chemical reaction of antioxidants interaction включает with active oxygen radicals. Results of studies showed that water and alcoholic extracts from waste of carbon dioxide extraction of top part of cream scabious show antioxidative activity.

Conclusions. As well, results of calculation of kinetic criterion, reflecting the amount of oxygen and active oxygen radicals, responded to total amount of antioxidants in extracts, prove the presence of antioxidative activity of water and alcoholic extract of waste of carbon dioxide extraction, conditioned by possible presence of OH-groups of phenol compounds and polysaccharides in hydrophilic fraction of waste of carbon dioxide extraction.

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Резюме

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ИНВЕРСИОНДЫ ВОЛЬТАМПЕРОМЕТРИЯ ӘДІСІМЕН
SCABIOSA OCHROLEUCA L. КӨМІРҚЫШҚЫЛЫ ЭКСТРАКЦИЯСЫ
ҚАЛДЫҚТАРЫНЫҢ АНТИОКСИДАНТЫНЫҢ
БЕЛСЕНДІ ЭКСТРАКЦИЯСЫН ЗЕРТТЕУ

Сары-ақшыл скабиоздың (*Scabiosa ochroleuca* L.) жер үсті бөлігіндегі көмірқышқылды экстракция қалдықтарының спирттік және сулы экстракттарының антиоксидантты белсенділігі (АОБ) зерттелген болатын. Сары-ақшыл скабиоз шөптерінің көмірқышқыл экстракция қалдықтарының спирттік және сулы экстракттарының антиоксидантты белсенділігін (АОБ) зерттеуде инверсионды вольтамперометрия әдісімен жүргізілді. 0,3 г салмақты экстракттың өлшемін ала отырып, аталған тәжірибені жүргізу үшін катодтық вольтамперометрия әдісі қолданылды. $W = 40$ мВ/с потенциалдық айырма жылдамдығы және потенциалдың жұмыс диапазоны 0,01-ден 1 В тұрақта тоқтық режимінде қолданылды. Электрохимиялық ұяшық фондық электрод ерітіндісі бар шынылы стақаннан және осы ерітіндіге батырылған сынапты-пленкалық электрод, салыстырмалы күміс-хлоридті электроді және күміс-хлоридті электродынан құралған. рН 6,6 тең фосфатты буферлі ерітінді – фондық ерітінді ретінде алынған. Зерттелетін үлгінің белсенділігінің көрсеткіші CO₂-ның белсенділік дәрежесінің өзгеруі болып саналады. 70%-ті спиртте және дистилденген суда көмірқышқылды экстракция қалдықтарын тұндырып, спирттік және сулы экстракттарын алды. Осыдан 350 г құрғақ массасын CO₂ экстракция қалдықтарынан алынған сары-ақшыл скабиоз экстракциясын таттанбайтын темірден жасалған контейнерге салынды. 70%-ті этил спиртін, дистилденген суды және 3 күн тұндырды. 250 мл болатын домалық түпті колбада сүзіп, роторлы буландырғышта еріткішті айдады. IKARV 10 Digital аспаптық роторлы буландырғышта 40-45 °С температурасында көмірқышқылды экстракция қалдықтарынан алынған экстракты концентрледі. Бұл жұмыс Қарағанды мемлекеттік техникалық университетінің базасында «Ғылыми зерттеу институтында» жүзеге асырылды.

Түйін сөздер: *Scabiosa ochroleuca* L., инверсионды вольтамперометрия, антиоксидантты белсенділік, кинетикалық критеріі, көмірқышқылы экстракциясы қалдықтары, биологиялық белсенді заттар.

Резюме

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ИЗУЧЕНИЕ АНТИОКСИДАНТНОЙ АКТИВНОСТИ ЭКСТРАКТОВ ИЗ ОТХОДА УГЛЕКИСЛОТНОЙ ЭКСТРАКЦИИ *SCABIOSA OCHROLEUCA* L. МЕТОДОМ ИНВЕРСИОННОЙ ВОЛЬТАМПЕРОМЕТРИИ

Изучена антиоксидантная активность (АОА) спиртового и водного экстрактов из отхода углекислотной экстракции надземной части скабиозы бледно-желтой (*Scabiosa ochroleuca* L.). Исследование АОА спиртового и водного экстракта из отхода углекислотной экстракции травы скабиозы бледно-желтой проводили методом инверсионной вольтамперометрии. Используя метод катодной вольтамперометрии, для проведения одного опыта, брали навеску экстракта весом 0,3 г. Использовался постоянноточковый режим катодной вольтамперометрии, скорость развертки потенциала $W = 40$ мВ/с, рабочий диапазон потенциалов от 0,0 до -1 В. Электрохимическая ячейка представляла собой стеклянный стаканчик с раствором фонового электролита и опущенными в него индикаторным ртутно-пленочным электродом, хлорид-серебряным электродом сравнения и хлорид - серебряным электродом. В качестве фонового раствора – фосфатный буфер с рН 6,6. Степень изменения тока ЭВ O_2 являлась показателем активности исследуемого образца. Спиртовый и водный экстракты из отхода углекислотной экстракции (CO_2 -шрот) получали настаиванием в спирте этиловом 70%-ном и дистиллированной воде, для этого брали 350 г воздушно-сухой массы CO_2 -шрота скабиозы бледно-желтой и помещали в контейнер из нержавеющей стали. Добавляли спирт этиловый 70%-ный / дистиллированную воду и настаивали в течение 3-х дней. Затем отфильтровывали в круглодонную колбу со шлифом объемом 250 мл и отгоняли растворитель на роторном испарителе. *Концентрирование экстрактов* из отхода углекислотной экстракции проводили на роторном испарителе IKARV 10 Digital при температуре 40-45 °С, на базе НИИ «Новые материалы», Карагандинского государственного технического университета.

Ключевые слова: *Scabiosa ochroleuca* L., инверсионная вольтамперометрия, антиоксидантная активность, кинетический критерий, отход углекислотной экстракции, биологически активные вещества.