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INVESTIGATION OF ANTIOXIDANT PROPERTIES OF AQUEOUS EXTRACTS OF *CHENOPÓDIUM ALBUM LINN*

Annotation. *Chenopodium album Linn is widespread throughout the territory of the West Kazakhstan region. An early annual, monoecious spring plant. It accompanies almost all cultivated plants. Herein, we report the studies of the antioxidant activity of aqueous extracts of leaves, stems and roots of Chenopodium album Linn growing in the ecological zone of the West Kazakhstan region. Total antioxidant capacity, total reducing power, 2,2-diphenyl-1-picrylhydrazyl and hydrogen peroxide scavenging activity for aqueous extracts from all parts of the plant were spectrophotometrically determined. It was found that extracts obtained from roots of Chenopodium album root has a high indicator of antioxidant activity (total antioxidant capacity 2.2 ± 0.21 mmolAA/g, total reducing power 0.41 ± 0.035 mmolAA/g, 2,2-diphenyl-1-picrylhydrazyl radical scavenging activity 75.76 ± 11.3%, hydrogen peroxide scavenging activity 92.0 ± 14.8%) which confirms its possibility to be used for medicinal purposes.*

Keywords: *Chenopódium album Linn; antioxidants; antioxidant activity; DPPH; total reducing power; water extracts; spectrophotometry; plant extracts; hydrogen peroxide; root extract.*

Introduction

Herbal medicines are medicinal products that contain plant materials as their physiologically active components. A large number of medicinal plants are currently used in the form of herbal medicines containing raw drugs to treat various human diseases. Therefore, in recent years, more and more attention has been paid to the search for new medicinal plants and the development of preparations from plant materials used in traditional medicine [1].

Medicinal plants contain a wide range of biologically active phytochemicals. They distributed in all parts of medicinal plants and in accordance with strong antioxidant properties can be widely used as alternatives to synthetic medicines in effective prevention of oxidative stress and as food preservatives and nutraceuticals [2].

Chenopodium album L., (*C. album*) belongs to family *Chenopodiaceae*, is an annual plant widely grown in Asia, Africa, Europe and North America. Traditionally, *C.album* is used in folk medicine in different parts of the world as diuretic, laxative, sedative, hepatoprotective and antiparasitic[3]. The leaves possesses antiphlogistic, antirheumatic and odontalgic properties, applied as wash or poultice to bug bites, sunstroke, rheumatic joints and swollen feets The presence of such valuable healing activities should be explained by the content of lipids, alkaloids, betaine, trigonelline, flavonoids, essential oil, sitosterol, vitamin C, triterpenoid saponins, phenolcarboxylic acid ferulic and vinylic in the composition *Chenopodium album* [4]. This plant was also used as antihelmintic, blood purifier and for the treatment of hepatic disorders, intestinal ulcers, and burns [5].

Broad territories of *Chenopodium album* growing can be considered from the standpoint of possible use as a cheap source of valuable biologically active compounds. It is small odorless monoecious spring herb, erect or ascending, up to 3.5 m in height equally distributed throughout the West Kazakhstan region. Shoots appear from March to mid-autumn. There are always many seeds

of this plant in the soil, which ensure the reproduction of the species. One plant produces about 100,000 seeds.

The available studies of antioxidant activities in *Chenopodium album* are not numerous. Such studies were carried out in Poland [6], India [7] and Italy [8]. The therapeutic value of *Chenopodium album* was confirmed due to the pharmacological studies. Therefore, there is a need to perform the complex study of this plant widespread in Kazakhstan, and firstly its antioxidant properties.

Materials and methods

Reagents and solvents. All the analytical grade chemicals were purchased from commercial suppliers and used directly without any purification. Double distilled water was used for extracts preparation.

Collection and preparation of plant material.

Fresh plants were collected from their native habitat in summer of 2022 in the flowering stage in the suburbs of Uralsk, away from roads and industrial enterprises. Plants were washed from soil and sand thoroughly with tap water, then 2-3 times with double distilled water and kept in a shaded ambient atmosphere for 2 weeks to total dryness. The dried samples were then pulverized to a coarse powder and stored at 4°C for further studies.

Extract preparation.

10 g of dried and pulverized plant material were transferred into 250 mL Erlenmeyer flask and extracted successfully 3 times x 100 mL for 4 h with double distilled water at 60^0C. Obtained extracts were combined and evaporated to solidification. The solid residue was dried at 50^oC to constant weight. The extracts were stored in labeled glass vials at 4^oC and subsequently subjected to determination of antioxidant activity. The concentrated extracts were weighed and percentage of yield (w/w) was calculated using the following equation:

$$\text{Extraction yield (mg/g)} = \frac{\text{mass of extract (mg)}}{\text{mass of dried sample (g)}}$$

Total antioxidant capacity (TAC) determination.

The total antioxidant capacity of the extracts was determined by phosphomolybdate assay with ascorbic acid as standard (0-100 mcg/ml, $y = 0{,}1368x - 0{,}1744$; $R^2 = 0{,}9987$) [9] at 765 nm against blank using Jenway 6305 spectrophotometer. Ascorbic acid (1 mg/mL) was also used as the positive control. TAC of the extracts was expressed in mmol of ascorbic acid equivalents per g of extract (mmolAA/g) [10].

Total reducing power (TRP) determination.

Total reducing power reflects the electron donating capacity of bioactive compounds, and serve as a significant indicator of its antioxidant capacity [11]. Method is based on the ability of antioxidants to reduce Fe(III) to Fe(II) in the presence of an extract [12]. The amount of Fe(II) formed was controlled by measuring of the formation of Prussian blue Pearl at 700 nm using a Jenway 6305 spectrophotometer. The values of the reducing activity of Fe(III)-Fe(II) was expressed in mmol of ascorbic acid equivalents per g of extract (mmolAA/g) (0-100 mcg/ml, $y = 0{,}2806x - 0{,}1065$; $R^2 = 0{,}9984$).

DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging activity.

The ability of the plant extracts to donate hydrogen atoms was determined using the decolorization of an alcohol solution of DPPH as described by Brand-Williams [13]. DPPH forms a purple colored solution when dissolving, which then changes to bright yellow in the presence of antioxidants.

For determination, 2 ml of the 0.1 mM DPPH alcoholic solution was mixed with the same volume of solution of extract at concentrations of 0.1, 0.25, 0.5, 0.75 and 1.0 mg/ml [14]. Mixture of DPPH with equal volume of the pure solvent in place of extract was used as control. The absorption of the reaction mixture was measured at 517 nm using a Jenway 6305 spectrophotometer

against pure solvent. The ability of extracts to scavenge DPPH radical was calculated using the following equation:

$$\text{DPPH scavenging activity} = \frac{A_0 - A_1}{A_0} \times 100$$

where, A_0 is the absorbance of the control, and A_1 is the absorbance of the extract.

Hydrogen peroxide scavenging activity (HPSA).

HPSA of the extracts was determined as described by Ruch [15]. The absorbance value of the reaction mixture was recorded at 240 nm using a Jenway 6305 spectrophotometer. Ascorbic acid at the same concentrations as extracts (0.1, 0.25, 0.5, 0.75, 1 mg/ml) was used as the positive control. Ability of the extracts to scavenge H_2O_2 was calculated using the following equation:

$$\text{HPSA (\%)} = \frac{A_0 - A_1}{A_0} \times 100$$

where A_0 is absorbance of control, A_1 is absorbance in the presence of the samples or standard.

Statistical analysis

Each experiment was carried out in triplicate (n = 3) and the data presented as an average of three independent determinations ± standard deviation (SD). Calculation of linear correlation coefficient and correlation analysis were carried out using MS Office Excel 2013.

Research results

Extraction yield, total antioxidant capacity (TAC) and total reducing power (TRP) determination.

The results of extraction yield, TAC and TRC determination are listed in Table 1.

Table 1. Extraction yield, total antioxidant capacity (TAC) and total reducing power (TRP) of aqueous extracts of different parts of Chenopodium album Linn.

Plant part	Extraction yield, mg/g	TAC, (mmolAA/g)*	TRP, (mmolAA/g)
Leaves	409.5 ± 26.8	0,56 ± 0,05	0,12 ± 0,023
Roots	148.8 ± 13.2	2,26 ± 0,21	0,41 ± 0,035
Stems	167.9 ± 19.7	0,83 ± 0,12	0,17 ± 0,021

*1 g of pure ascorbic acid corresponds to 5.67 mmol.

As can be seen from Table 1, determined extraction yield ranged from 167.9 ± 19.7 mg/g of dry weight (stems) to 409.5 ± 26.8 (leaves) that corresponds to 16.7 and 40.1% respectively. Extracts obtained from roots have the most antioxidant capacity among other extracts (2,26 ± 0,21 mmolAA/g). Stems (0,83 ± 0,12 mmolAA/g) and leaves (0,56 ± 0,05 mmolAA/g) demonstrated significantly less values of TAC. Total reducing power of *Chenopodium album* extracts was demonstrate the same trend as TAC. According to the ability to reduce Fe(III) to Fe(II), all the studied extracts, can be placed in the following row according to the value of antioxidant activity: roots > stems > leaves.

DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging activity.

The capture of free radicals plays an important role in the formation of a general system of antioxidant activity, including for living cells [16]. DPPH is one of the widely used reagents for determining antiradical activity due to its simplicity, clarity, measurement accuracy, and wide approbation. The results of *Chenopodium album* leaves, roots and stems extracts DPPH radical scavenging activity determination are shown in Fig.1.

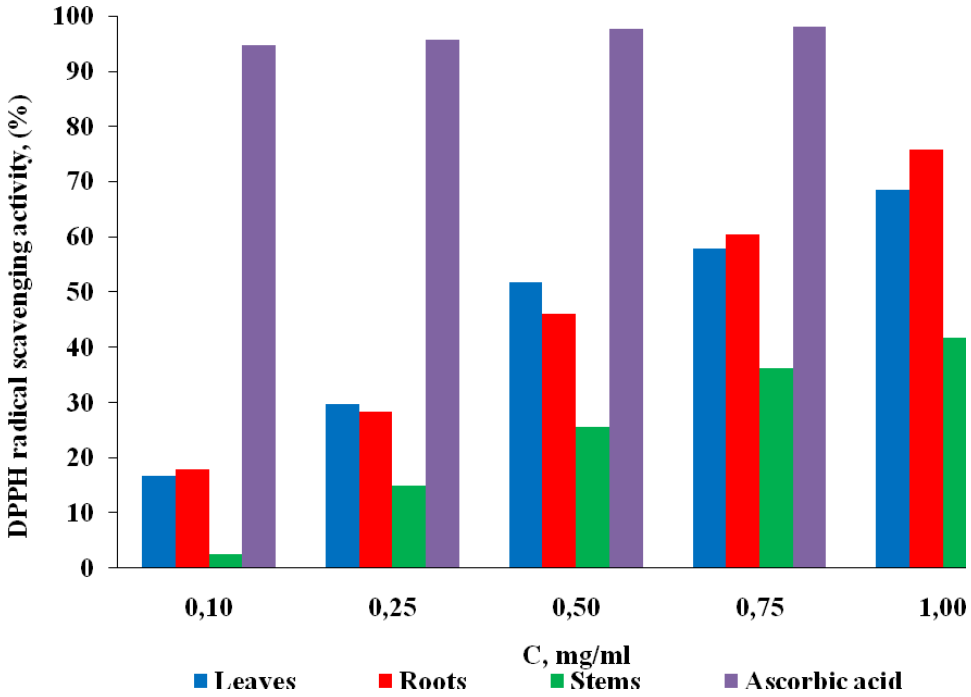

Figure 1 - The DPPH scavenging activity of aqueous extracts of Chenopodium album at different concentrations

As can be observed in Figure 1, all parts of the plant demonstrates the great ability to scavenge DPPH radicals in a straightly concentration dependent manner. Ability of extracts to scavenge DPPH-radicals ranged from 2.43 ± 0.3 % for stems extract at 0.1 mg/ml to the highest level of 75.76 ± 11.3% found for root extract. Higher concentrations of the extracts were more effective in quenching free radicals in the system. At 1 mg/mL concentration, extracts from all the plant parts produced high DPPH-radical scavenging activity. Nevertheless, ascorbic acid showed higher DPPH-scavenging activity than extracts. The result found clearly demonstrates that the bioactive compounds contained in this plant have a polar character are able to easy scavenge of DPPH-radicals.

Hydrogen peroxide scavenging activity (HPSA).

Hydrogen peroxide can be formed in living cells by many oxidase enzymes such as superoxide dismutase. It can sometimes be toxic to cell when after crossing membranes oxidize a number of compounds leading to the rise of hydroxyl radical concentration. Thus, the removing of H_2O_2 is very important for antioxidant defense in cell or food systems. The scavenging ability of *Chenopodium album* aqueous extracts on hydrogen peroxide is shown in Fig. 2 compared with pure ascorbic acid as standard.

Fig. 2 reveals that a significant amount dependent response was also found in the hydrogen peroxide scavenging activity by extracts. Maximum scavenging activity (92.0 ± 3.9 %) was observed at 1.0 mg/ml concentration of roots extract. As can be seen, extracts from *Chenopodium album* roots and leaves were capable of scavenging hydrogen peroxide even in low concentrations. Stems extracts demonstrates very poor ability to scavenge of hydrogen peroxide. With an increase in extracts concentration, the antioxidant activity for the scavenging of H_2O_2 also increases. The scavenging abilities on hydrogen peroxide is in descending order of roots > leaves > stems. At the same time, in terms of the effectiveness of the destruction of hydrogen peroxide, *Chenopodium album* aqueous extracts are insignificantly inferior to pure ascorbic acid, but their activity is quite high.

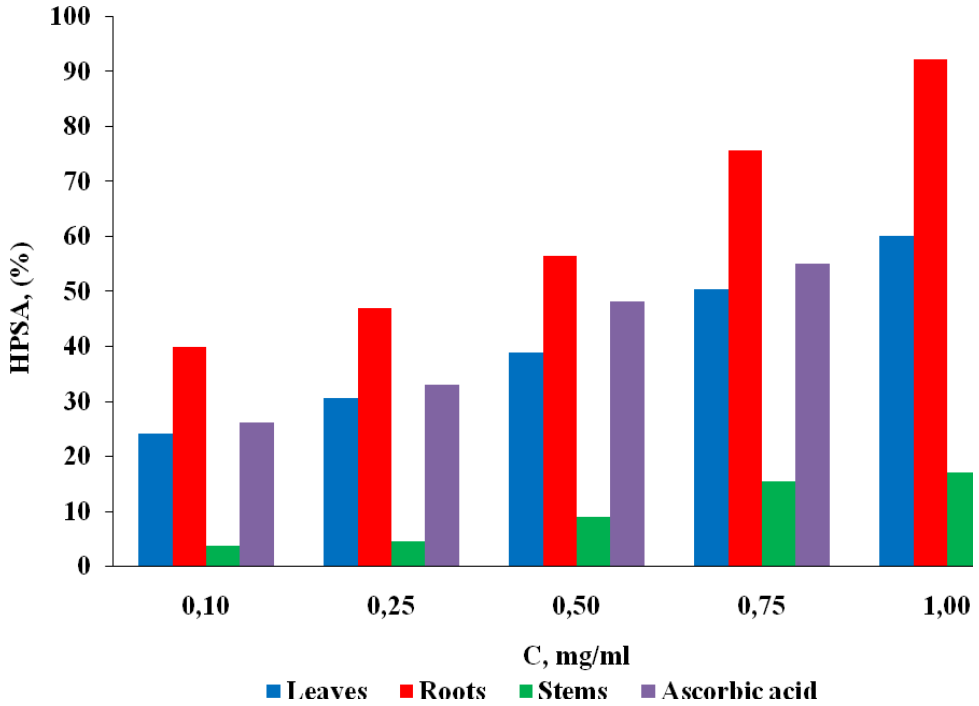

Figure 2 – The HPSA scavenging activity of aqueous extracts of Chenopodium album at different concentrations

Conclusion

Medicinal plants have the ability to synthesize a variety of chemical compounds due to which important biological functions are performed. To create new, environmentally friendly and safe medicines, it is necessary to increase efforts on phytochemical, as well as antioxidant analysis of medicinal plants. In this regard, the main purpose of this study was to determine the antioxidant activity aqueous extracts of different parts of *Chenopodium album* growing on the West Kazakhstan region. Our investigation revealed that *Chenopodium album* is an important medicinal plant with diverse spectrum of antioxidant properties. It has been established that the plant demonstrates high antioxidant capacity to scavenge DPPH and neutralize hydrogen peroxide. Thus, *Chenopodium album* still one of the most abundant and useful medicinal plants with a wide potential for further research and the search for new opportunities for its use for phytotherapeutic purposes.

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ИССЛЕДОВАНИЕ АНТИОКСИДАНТНЫХ СВОЙСТВ ВОДНЫХ ЭКСТРАКТОВ CHENOPODIUM ALBUM LINN

Аннотация. *Chenopodium album Linn распространена на всей территории Казахстана. Раннее однолетнее, однодомное яровое растение. Сопутствует практически всем культивируемым растениям. В настоящей работе мы сообщаем об исследованиях антиоксидантной активности водных экстрактов листьев, стеблей и корней Chenopodium album Linn, произрастающих в экологической зоне Западно-Казахстанской области.*

Спектрофотометрически определяли общую антиоксидантную способность, общую восстанавливающую способность, активность по удалению 2,2-дифенил-1-пикрилгидразила и перекиси водорода для водных экстрактов из всех частей растения. Установлено, что экстракты, полученные из корней Chenopodium album, обладают высоким показателем антиоксидантной активности (общая антиоксидантная емкость 2,2 ± 0,21 ммолАА/г, общая восстанавливающая способность 0,41 ± 0,035 ммолАА/г, активность по удалению 2,2-дифенил-1-пикрилгидразилрадикалов 75,76 ± 11,3%, активность по удалению перекиси водорода 92,0 ± 14,8%), что подтверждает его возможность использования в лечебных целях.

Ключевые слова: *Chenopódium album Linn; антиоксиданты; антиоксидантная активность; DPPH; восстанавливающая способность; водные экстракты; спектрофотометрия; растительные экстракты; перекись водорода; экстракт корня.*

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CHENOPODIUM ALBUM LINN СУ СЫҒЫНДЫСЫНЫҢ АНТИОКСИДАНТТЫҚ ҚАСИЕТТЕРІН ЗЕРТТЕУ

Аңдатпа*. Chenopodium album Linn Қазақстанның барлық аумағында таралған. Ерте жылдық, біртектес жаздық өсімдік. Барлық дерлік өсірілетін өсімдіктермен бірге жүреді. Жұмыста біз Батыс Қазақстан облысының экологиялық аймағында өсетін Chenopodium album Linn жапырақтарының, сабақтарының және тамырларының су сығындыларының антиоксиданттық белсенділігін зерттеу туралы хабарлаймыз. Спектрофотометриялық тұрғыдан өсімдіктің барлық бөліктерінен су сығындылары үшін 2,2-дифенил-1-пикрилгидразил мен сутегі асқын тотығын жою белсенділігі, жалпы қалпына келтіру қабілеті, жалпы антиоксиданттық қабілеті анықталды. Chenopodium album тамырларынан алынған сығындылардың антиоксиданттық белсенділігі жоғары екендігі анықталды (жалпы антиоксиданттық сыйымдылығы 2,2 ± 0,21 ммолАА/г, жалпы қалпына келтіру қабілеті 0,41 ± 0,035 ммолАА/г, 2,2-дифенил-1-пикрилгидразил радикалдарын жою белсенділігі 75,76 ± 11,3%, сутегі пероксидін кетіру белсенділігі 92,0 ± 14,8%), бұл оның емдік мақсатта пайдалану мүмкіндігін растайды.*

Кілт сөздер: *Chenopódium album Linn; антиоксиданттар; антиоксиданттық белсенділік; DPPH; қалпына келтіру қабілеті; су сығындылары; спектрофотометрия; өсімдік сығындылары; сутегі асқын тотығы; тамыр сығындысы.*