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Determination of the Chemical Composition and Antioxidant Activity of *Artemisia vulgaris* and *Artemisia absinthium* Growing in the Conditions of the Semey Region

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Abstract

BACKGROUND: The action of the main biologically active substances contained in medicinal products becomes obvious in combination with the action of macro- and micro-elements that determine the natural mineral composition of the plant.

AIM: The objective of this study was comparative study of the composition of macro- and micro-elements of two representatives of the genus *Artemísia* L. on the example of *Artemisia vulgaris* and *Artemisia absinthium* and their antioxidant activity.

METHODS: In this work, the following stages of the study were used: Gathering and preparation of medicinal plant (MP) materials; method of sampling the test material for analysis; determination of humidity; and determination of the quantitative composition by inductively coupled plasma mass spectrometry (ICP-MS) and atomic emission spectrometry ICP (AES-ICP). Determination of antioxidant activity was carried out by photometry. The accuracy of the analysis results was checked by the method of standard additives. Each sample was accurately analyzed in accordance with the recording of the instrument methodology. The necessary operating modes of the mass spectrometer were set in accordance with the manufacturer's recommendations. To verify the reliability (accuracy) of the analysis results of micro- and macro-elements of MP, the determination was carried out by two methods: ICP-MS with ICP and AES-ICP.

RESULTS: It has been established that the indicators of the investigated MP do not exceed the permissible values for the content of residual moisture and ash. The presence of macro- and micro-elements in both objects of the study is also shown. Quercetin was identified in *A. absinthium* and *A. vulgaris*.

CONCLUSION: The obtained results of qualitative and quantitative indicators of the content of macro- and micro-elements, such as potassium, calcium, sodium, magnesium, copper, iron, manganese, as well as an analysis of the antioxidant activity of samples of *A. absinthium* and *A. vulgaris*, allow us to conclude that the studied plants are promising as a component composition for creating preparations based on them.

Introduction

In the flora of Kazakhstan, more than 100 species of plants are medicinal plants (MPs). The available resources of the vast majority of these plants, with their expedient harvesting, would be sufficient to meet the needs of medicine in the Republic of Kazakhstan (RK), but currently only 5% of them are of industrial importance [1].

The unique flora of the RK and the presence of rare endemic plants contribute to the development of pharmaceutical products which has export opportunities for the country [2].

Many species of wormwood, in particular *Artemisia absinthium*, *Artemisia dracunculus*, *Artemisia santonicum*, and *Artemisia spicigera*, are successfully used in medicine [3]. It has been established that different types of wormwood differ significantly in chemical composition and pharmacological properties, as well as in the degree of toxicity [4]. Therefore, it is necessary to conduct a study of the chemical composition of various representatives of the genus *Artemisia* to identify the prospects for their medical use.

The objective of our study is the quantitative determination of mineral substances and the content of antioxidant substances in wormwood (*Artemisia vulgaris*) and wormwood (*A. absinthium*), the type species of the genus Wormwood.

The choice of this plant is due to the fact that they have a wide range of physiological and pharmacological activity, in particular, antiviral [5], antitumor [6], anti-inflammatory, antifungal [7], and antioxidant [8]. Furthermore, on the territory of the

Semey region, there are large reserves of these plants.

As it is known, the study of the mineral composition of MPs is important, first, the chemical composition of MP growing in a certain territory can be considered as a kind of reflection of the ecological situation in this region, characterizing the ecological purity of MP. Second, the action of the main biologically active substances (BAS) contained in medicines is in combination with the action of macro- and micro-elements that determine the natural mineral composition of the plant.

It is also known that the causes of many diseases (cardiovascular, gastrointestinal, malignant tumors, etc.) are the accumulation of excessive concentrations of free radicals in the body. To regulate the concentration of radicals in living organisms, special substances are produced – various enzymes and vitamins, with antioxidant properties. These compounds are destroyers for free radicals. For the prevention of the above diseases, medicines containing plant-based antioxidants are recommended.

However, the set of antioxidants in plants is much richer than in animal and human tissues. This is due to the fact that plants practically have no other means of protection from aggressive environmental influences. There are about 8000 antioxidants of plant origin, combined under the general term – flavonoids [1], [9].

Most studies on the identification of individual flavonoids in MPs are based on the determination of their physicochemical characteristics. An analysis of the literature data showed that various chromatographic [10], [11], [12], electrochemical [12], [13], and electrophoretic [14] methods of analysis are used for this purpose. The simplest and most accessible method is the spectrophotometric determination of the amount of flavonoids in some herbal medicines [15], [16].

The antioxidant composition of each plant is unique both in qualitative and quantitative terms. Each plant, having a unique composition of bio-antioxidants, simultaneously depends on the growing season, geographical location, and climatic conditions of growth [4], [17], [18], [19].

Therefore, before recommending MP as a product containing antioxidants and minerals, it is mandatory to study them.

Materials and Methods

The samples of *A. vulgaris* and *A. absínthium* subjected to air-drying were the objects of study. The studied objects were standardized in accordance with the general requirements of the State pharmacopoeia (SP) of the RK and SP XIII for the content of residual moisture, ash, and content of extracted substances [20], [21], [22], [23].

Preparation of samples for research

As it is known, all MPs should be harvested at a certain time, since the vegetation phase or the development phase plays an important role in the accumulation of active substances in the plant. The aerial parts of plants accumulate the maximum amount of active substances most often during the flowering period (June–August) – at this time, they should be collected. Fruitage contains the greatest amount of medicinal substances during full ripening; roots and rhizomes – in late autumn, after withering of the aerial parts of plants [24].

The flowers of the plant for analysis were collected in summer on a sunny day in different areas of the Semey region and were dried in the shade to an air-dry state at the selection site. The underground parts were dug out in the fall and washed before drying. Then, they were crushed for analysis, and an average sample was prepared, which was stored in jars with a lap joint cap [24].

The determination of each parameter was carried out with five samples of each batch of raw materials. The objects of study were harvested at the same time from the same growing area, which makes it possible to exclude the influence of environmental factors on the difference in chemical composition between representatives of *A. vulgaris* and *A. absínthium*.

Determination of humidity

Raw material moisture is the mass loss due to hygroscopic moisture and volatile substances, which are determined in the analyzed plant material by drying to a constant weight. To determine the humidity of MP, the method of drying to a constant mass in a drying apparatus at a temperature of 105°C was used. Three portions weighing 3–5 g, weighted with an error of ± 0.01 g, were taken. Each portion was placed in a pre-weighed weighing bottle with a stopper and placed in a heated drying apparatus. Drying was carried out to constant mass. Constant weight is considered to be reached if the difference between two subsequent weightings after 30 min of drying and 30 min of cooling in a desiccator does not exceed 0.01 g.

The moisture content of raw materials (X) as a percentage was calculated by the formula:

Where, m is the mass of raw materials before drying in grams;

$$X = \frac{(m - m_1)}{m} 100,$$

m_1 – mass of raw materials after drying in grams.

The arithmetic mean of parallel determinations was taken as the final result. The results of the analyses are presented in Table 1.

Table 1: Numerical indicators of medicinal plants

MP	Indicators (%)	Resulting values (%)	Recommended norms (%)
Artemisia vulgaris	8.71 ± 0.55	6.55 ± 0.33	No more 9.0
Artemisia absinthium	8.55 ± 0.45	6.75 ± 0.38	No more 7.0

MP: Medicinal plant.

Determination of total ash

The ash of plant raw materials is the residue of inorganic substances obtained after burning the raw materials and subsequent calcination of the residue to constant weight. A 3–5 g of crushed herbal raw materials (accurately weighed) was placed in a pre-calcined and precisely weighed porcelain crucible, distributing the substance evenly over the bottom of the crucible. The crucible was then gently heated, allowing the substance to burn first at the lowest possible temperature. The combustion of the remaining coal particles was also carried out at the lowest possible temperature; after the coal burned almost completely, the flame was increased. The calcination was carried out at a low red heat to a constant mass, avoiding the fusion of the ash and its sintering with the walls of the crucible. After the calcination was completed, the crucible was cooled in a desiccator and weighed. The content of total ash in percent (X) in absolutely dry raw materials was calculated by the formula:

$$X = \frac{m_1 100100}{m_2 (100 - W)}$$

Where, m_1 is the mass of ash in grams;

m_2 – the mass of raw materials in grams;

W – the weight loss during drying of raw materials in percent.

The results of the analyses are presented in Table 1.

The analysis of micro- and macro-elements of MP was carried out by inductively coupled plasma mass spectrometry (ICP-MS) on the Agilent 7700 X device and by atomic emission spectrometry ICP (AES-ICP) on the iCAP 6300 Duo device in the laboratories of the Institute of Radiation Safety and Ecology of the National Nuclear Center of the RK.

Summary of test method

ICP maintained in a special burner excites ions from the atoms of the injected sample. Next, the ions are focused by the ion-optical system and enter the mass spectrometer analyzer. The ion stream then enters the detector for quantitative registration. This method determines the concentrations of elements at the level of hundredths of nanograms to hundreds of milligrams per liter ($1 \cdot 10^{-12}$–$1 \cdot 10^{-2}$%). The achievable detection limits and high sensitivity and selectivity of the ICP-MS method allow measure up to 40–50 elements in samples of plant origin within 2–3 min (excluding sample preparation time) [25].

Processing of measurement results

The analytical signals were processed by the mass spectrometer software based on the constructed calibration linear regressions calculated by the least squares method, taking into account the background correction, the signal of internal standards. The result of determining each element was presented as the average of several (at least two) parallel measurements of the analyzed sample. The measurement results were displayed on the monitor, printed out, and saved as a file on the computer's hard disk.

For the construction of calibration graphs, multielement standard solutions were used, registered in the registry of the SSM RK under No. KZ. 03.02.00901–2010 and KZ.03.02.00902–2010. Measurement quality control was carried out by measuring the calibration solution every 10 samples. If the calibration result was unsatisfactory (the deviation of the calibration schedule by 8–10%), the instrument was recalibrated, which took into account new background parameters [26].

Table 2: Results of mass spectral analysis of medicinal plants conducted by microwave decomposition, mg/g

Medical plants	Macronutrient content mg/g, mean ± SD			
	Potassium (K)	Calcium (Ca)	Magnesium (Mg)	Selenium (Se)
Artemisia vulgaris	15.20 ± 0.45	6.75 ± 0.24	1.51 ± 0.15	16.55 ± 0.39
Artemisia absinthium	16.65 ± 0.55	7.40 ± 0.58	1.85 ± 0.24	17.77 ± 0.57

SD: Standard deviation.

The methodology of analysis and sample preparation of samples (dry ignition, wet ignition, and microwave decomposition) of plants for analysis by the methods of ICP-MS and AES-ICP is described in work [27]. The results of the analyses are presented in Tables 2-4.

Table 3: Results of mass spectral analysis of medicinal plants conducted by microwave decomposition, mg/g

Microelements	Macroelements content mg/g Medical plants, mean ± SD	
	Artemisia vulgaris	*Artemisia absinthium*
Manganese (Mn)	0.34 ± 0.05	0.41 ± 0.05
Copper (Cu)	0.64 ± 0.05	0.59 ± 0.04
Zinc (Zn)	0.43 ± 0.05	0.37 ± 0.03
Cobalt (Co)	0.62 ± 0.04	0.70 ± 0.05
Nickel (Ni)	0.67 ± 0.05	0.72 ± 0.06
Ferrrum (Fe)	0.13 ± 0.04	0.15 ± 0.03
Lead (Pb)	0.01 ± 0.003	0.02 ± 0.002
Aluminum (Al)	0.05 ± 0.003	0.05 ± 0.003
Chromium (Cr)	0.12 ± 0.04	0.09 ± 0.03
Strontium (Sr)	0.45 ± 0.05	0.40 ± 0.05

SD: Standard deviation.

To determine the antioxidant activity of an aqueous infusion of wormwood (*A. vulgaris*), a 0.001N aqueous solution of 2,6-dichlorophenolindophenolate

Table 4: Results of atomic emission spectrometric analysis of medicinal plants conducted by microwave decomposition, mg/kg

Elements	*Artemisia vulgaris*, mean ± SD		*Artemisia absinthium*, mean ± SD	
	Above ground parts	Underground parts	Above ground parts	Underground parts
Macroelements				
Sodium (Na)	200 ± 27	170 ± 13	31000 ± 3200	1300 ± 74
Calcium (Ca)	1500 ± 260	1400 ± 130	680 ± 61	920 ± 44
Potassium (K)	5900 ± 1000	1200 ± 120	12000 ± 1300	940 ± 48
Magnesium (Mg)	2100 ± 370	670 ± 37	1400 ± 170	860 ± 23
Microelements				
Iron (Fe)	260 ± 43	740 ± 65	480 ± 43	840 ± 45
Copper (Cu)	9.1 ± 0.2	7.7 ± 0.1	18.0 ± 0.3	16.0 ± 0.1
Zinc (Zn)	36 ± 2	89 ± 1	18 ± 1	19 ± 1
Manganese (Mn)	160 ± 2	750 ± 6	83 ± 1	59 ± 1

SD: Standard deviation.

sodium (Na) was used [28], [29]. Flower-bearing leafy tops of common wormwood were selected as objects.

A quercetin solution in ethyl alcohol with a quercetin concentration of 1 mg/ml was used as a standard antioxidant.

Wormwood extract was obtained as follows: After harvesting, the plant was dried in a drying apparatus at 40°C to a constant mass, then ground in a ceramic mortar to a powdery state. Twice distilled benzene was added to the resulting powder at room temperature in a ratio of 1:20 and allowed to stand for 1 day. Then, it was filtered with a paper filter. The filtrate was evaporated at room temperature to a constant mass. The resulting initial extract of wormwood was diluted by adding 100 ml of water.

Test sample

A 10 cm^3 of water and 1 cm^3 of 0.001 n solution of 2,6-dichlorophenolindophenolate of Na were mixed. The optical density of the obtained $A_к$ solution was determined on a photoelectrocolorimeter at a wavelength of 500–520 nm; water was used as a comparison solution.

Sample with an extract of wormwood

A 10 cm^3 of the analyzed sample of common wormwood and 1 cm^3 of a solution of 2,6-dichlorophenolindophenolate Na were mixed. After 5 min of the reaction, the optical density of the obtained A_n solution was determined on a photoelectrocolorimeter at a wavelength of 500–520 nm; in the comparison solution, 2,6-dichlorophenolindophenolate Na was replaced with water.

Sample with a standard antioxidant

A 10 cm^3 of an alcoholic quercetin solution and 1 cm^3 of a 2,6-dichlorophenolindophenolate Na solution were mixed. After 5 min, the optical density of the obtained A_c solution was determined on a photoelectrocolorimeter at a wavelength of 500–520 nm; in the comparison solution, 2,6-dichlorophenolindophenolate Na was replaced with water.

The calculation of the indicator of the total antioxidant activity of wormwood was carried out according to the formula:

$$AOA = \frac{(A_k - A_n)C_c Vk}{(A_k - A_c)m}$$

Where, AOA is the value of antioxidant activity equivalent to quercetin, mg/g;
A_k – the optical density of the control solution;
A_c – the optical density of a standard antioxidant (quercetin);
A_n – the optical density of the analyzed sample;
C_c – the concentration of a standard antioxidant (quercetin) in solution, mg/ml;
V – the total volume of the initial sample solution, ml;
k – the degree of dilution of the initial sample solution;
m – the weight of the sample to be analyzed, g.

Results and Discussion

One of the indicators of the quality factor and authenticity of vegetable raw materials, along with the composition, is its moisture and ash content. The humidity in the studied objects was 8.55–8.71%. It is usually no more than 12–15% for the MP. It is unacceptable to store raw materials with high humidity, as it has a significant impact on the quality of raw materials during storage.

The total ash content was 6.55–6.75%, which does not exceed the permissible values for the content of residual moisture and total ash. According to the content and composition of the ash elements of MPs, they judge the species, growth and development of plants, and especially from the soil-climatic and ecological conditions of their cultivation.

The nature of the concentration of macronutrients such as potassium (K), magnesium (Mg), and Na, as well as microelements such as copper (Cu), iron (Fe), manganese (Mn), zinc (Zn), chromium (Cr), nickel (Ni), cobalt (Co), and lead (Pb), varies in the studied MPs depending on the season and the places of collection of these plants. As a result of the analysis, the content of micro- and macro-elements in all samples was found to be within acceptable norms [30].

The data obtained (Tables 2-4) showed that the content of minerals in the studied MP is comparable to those in MPs (according to literature data).

Toxic elements such as cadmium, lead, and arsenic are absent. This makes it possible to conclude about the favorable situation of the Semey region.

Thus, it was found that the studied MP contains macroelements such as potassium, calcium, Na, and Mg and microelements copper, iron, and manganese. The contents correspond to such indicators for the MP.

The results of determining the antioxidant activity of three samples of wormwood equivalent to quercetin are given in Table 5.

Table 5: Antioxidant activity of medicinal plant samples, mg/g

Object	Antioxidant activity of samples of MP in terms of quercetin (mean ± SD)		
	Sample 1	Sample 2	Sample 3
Artemísia vulgáris	32.77 ± 1.40	28.54 ± 1.10	44.87 ± 2.14
Artemísia absínthium	42.16 ± 1.30	42.40 ± 1.60	45.57 ± 2.15

Analysis of the antioxidant activity of samples of wormwood has shown that the plant can be a potential source of antioxidants.

As is known, many natural compounds have sufficient resistance to oxidative damage. This is due to the existence of effective antioxidant systems in the plant cell, they will provide protection from oxygen radicals and singlet oxygen.

The most important antioxidants of the cell include vitamins (C, E, and the precursor of Vitamin A – β-carotene), antioxidant enzymes (for example, superoxide dismutase [SOD]), as well as polyphenols, which are traditionally called tanning substances or tannins.

Therefore, before recommending MP as a product containing antioxidants and minerals, it is mandatory to study them. Antioxidants are now being actively researched.

The aim of this work was also to study the total content of antioxidants of the common wormwood phenolic type based on the standard – quercetin by photometric method, ascorbic acid by iodimetric titration, and the activity of SOD by spectrophotometric method [31].

Flower-bearing leafy tops of common wormwood were selected as objects

Wormwood extract was obtained as follows: After harvesting, the plant was dried in a drying cabinet at 40°C to a constant mass, then 10 g of raw materials were ground in a ceramic mortar to a powdery state. Twice distilled benzene was added to the resulting powder at room temperature in a ratio of 1:20 and allowed to precipitate for 1 day then filtered with a paper filter. The filtrate was evaporated at room temperature to a constant mass. The resulting initial extract of wormwood was diluted by adding 100 ml of water in a measuring flask.

Determination of ascorbic acid by iodimetric titration

A 20 cm^3 of filtrate was taken into a conical flask, 1 cm^3 of 2 N hydrochloric acid solution, 0.5 cm^3 of potassium iodide solution, and 2 cm^3 of 0.001 M potassium iodate solution were added until stable blue staining. In parallel, control titration was carried out, where the same amount of distilled water was taken instead of 20 cm^3 of the filtrate.

About 0.5% starch solution was prepared in distilled water. A 30 ml of water was added to 0.5 g of starch powder, thoroughly mixed and heated to a boil. A 70 ml of cold distilled water was poured into the resulting solution and cooled.

Preparation of a solution of 0.003 N of iodine. A 3 ml of 0.1 N iodine solution in potassium iodide was added to 97 ml of distilled water. A 1 cm^3 0.001 M of potassium iodate solution corresponds to 0.088 mg of ascorbic acid. The content of ascorbic acid was determined by the formula:

$$X = \frac{v*0.000088*300*100*100}{m*(100 - W)}$$

Where, V is the volume of iodine solution, ml;
m is the mass of raw materials, g;
W – humidity (%);
100 – conversion to percentage;
100 – conversion to the mass of absolutely dry substance (ADS)

The analysis of the results showed that the Vitamin C content varies, the greatest intensity of Vitamin C accumulation (from 59.64 g to 74.78g per 100 g of ADS), it was in the fall [32].

Determination of the content of phenolic-type antioxidants based on the standard - quercetin by photometric method

To determine the antioxidant activity of an aqueous infusion of wormwood (*A. vulgaris*), a quercetin solution in ethyl alcohol with a quercetin concentration of 1 mg/ml was used as a standard antioxidant.

A 0.001 N aqueous solution of 2, 6-dichlorophenolindophenolate of Na was used [7]. Flower-bearing leafy tops of common wormwood were selected as objects.

A control sample

A 10 cm^3 of water and 1 cm^3 of 0.001 n solution of 2,6-dichlorophenolindophenolate of Na were mixed. The optical density of the obtained $A_к$ solution was determined on a photoelectrocolorimeter at a wavelength of 500–520 nm; water was used as a comparison solution.

A sample with an extract of wormwood (A. vulgaris and A. absínthium)

A 10 cm^3 of the analyzed sample of common wormwood and 1 cm^3 of a solution of 2,6-dichlorophenolindophenolate Na were mixed. After 5 min of the reaction, the optical density of the obtained A_n solution was determined on a photoelectrocolorimeter at a wavelength of 500–520 nm; in the comparison

solution, 2,6-dichlorophenolindophenolate Na was replaced with water.

A sample with a standard antioxidant

A 10 cm^3 of an alcoholic quercetin solution and 1 cm^3 of a 2,6-dichlorophenolindophenolate Na solution were mixed. After 5 min, the optical density of the obtained A_c solution was determined on a photoelectrocolorimeter at a wavelength of 500–520 nm; in the comparison solution, 2,6-dichlorophenolindophenolate of Na was replaced with water.

The calculation of the indicator of the total antioxidant activity of wormwood was carried out according to the formula:

$$AOA = (A_к\text{-}A_n) \cdot c_c \cdot v \cdot к/(A_к\text{-}A_c) \cdot m,$$

Where, AOA is the value of antioxidant activity in terms of quercetin, mg/g;
$A_к$ is the optical density of the control solution;
Ac – optical density of a standard antioxidant (quercetin);
A_n – optical density of the analyzed sample;
c_c is the concentration of a standard antioxidant (quercetin) in solution, mg/ml;
v is the total volume of the initial sample solution, ml;
k – the degree of dilution of the initial sample solution;
m is the weight of the sample to be analyzed, g.

Determination of SOD in samples of common wormwood (A. vulgaris and A. absínthium)

The method is based on determining the activity of SOD by assessing the degree of inhibition by SOD of the reaction of reduction of nitroblue tetrazolium (NBT) to formazan by superoxide radicals generated by the system of enzymatic oxidation of xanthine to uric acid in the presence of xanthine oxidase [33].

Before starting the reaction, the intrinsic xanthine oxidase activity of the test sample (E3) was determined. To do this, the test sample was added to the incubation medium containing no xanthine oxidase in the cuvette. The change in optical density was recorded for 3–5 min at a wavelength of 560 nm according to the obtained kinetic curve. The reaction rate of the reduction of NBT by a superoxide radical generated by its own xanthine oxidase of the test sample is expressed in units of the increase in the optical density of the solution per minute in terms of the amount of protein in the sample. If the optical density of the solution changes more than 0.001 units per minute, then it is entered into the formula for calculating the activity of SOD (E3).

A 73 ml of 0.1 mM xanthine solution in 0.5 N NaOH was added to the incubation mixture containing solutions of Na carbonate – 50 mM, EDTA – 0.1 mM, and NBT – 37.5 microns in a 50 mM phosphate buffer pH 10.2. The reaction was started by adding xanthine oxidase (0.05 units of activity per sample).

The change in the optical density of the solution along the kinetic curve was recorded for 3–5 min at a wavelength of 560 nm and the initial recovery rate of the NBT without SOD was determined.

The change in optical density in 1 min was calculated in terms of the amount of protein in the sample (E0).

A test sample containing SOD in an amount leading to a change in the optical density of the solution associated with the reduction of NST 0.017–0.02 units per minute was added to the same cuvette and selected experimentally for the same type of samples so that the measurement took place under conditions of an excess of substrate, which leads to a proportional change in the recorded reaction rate.

The optical density of the obtained kinetic curve (E2) was measured.

The amount of protein in the studied sample was measured.

The SOD activity of the studied material was calculated according to the formula in which we used the molar extinction coefficient of the resulting diformazan: (E=3.0 mM/cm [33].

The calculation of the activity of SOD is carried out according to the formula:

$$\frac{E_0 \quad E_1}{} 100$$

Where, E_0 is the change in the optical density of a solution of reducing NBT without SOD in 1 min;

E_1 is the change in the optical density of solution of the reducing NBT in the presence of SOD of the studied sample in 1 min.

The amount of protein in the studied sample is measured.

The SOD activity of the studied material is calculated according to the formula in which we used the molar extinction coefficient of the resulting diformazan: (E=3.0 mM/cm [33]):

$$\frac{\left(\frac{E_1}{\min}+\frac{E_3}{\min}\right)-\frac{E_2}{\min}}{310^{-2}}\frac{(2150+V)\,mcl}{VC}$$
$$= U\left(mcM\ formazan/mg\ protein/\min\right)$$

Where, U is the unit of enzyme activity; 2150 μl – the volume of the incubation medium; 3·× 10^{-2} – the molar extinction coefficient of diformazan;

V – the volume of the test material; C – protein concentration, mg/ml; E1 – units of optical density of a solution reducing NBT to diformazan without SOD in 1 min;

E2 – units of optical density of the solution reducing NBT to diformazan in the presence of SOD of the studied sample in 1 min;

E3 – units of optical density of the solution reducing NBT to diformazan by superoxide generated by xanthine oxidase of the studied sample.

The difference in the amount of reduced diformazan without the participation of SOD and the amount of diformazan reduced by inhibiting this reaction of SOD in 1 min in 1 ml of solution, in terms of 1 mg of protein in the sample, is taken as a unit of SOD activity. U = (microns of formazan/mg of protein/min).

Table 6: Antioxidant activity of phenolic type samples *Artemisia vulgaris* and *Artemisia absinthium*, mg/g

Object	Antioxidant activity of samples *Artemisia vulgaris* and *Artemisia absinthium* in terms of quercetin (mean ± SD)		
	Sample 1	Sample 2	Sample 3
Artemisia vulgaris	32.77 ± 1.40	28.54 ± 1.10	44.87 ± 2.14
Artemisia absinthium	34.52 ± 1.24	32.25 ± 1.09	49.62 ± 2.08

SD: Standard deviation.

The results of determining the antioxidant activity of wormwood samples are given in Tables 5-8.

Table 7: Ascorbic acid content in samples *Artemisia vulgaris and Artemisia absinthium*, mg/g

Object	Antioxidant activity of AC in samples *Artemisia vulgaris* and *Artemisia absinthium* (mean ± SD)		
	Sample 1	Sample 2	Sample 3
Artemisia vulgaris	59.64 ± 1.20	66.44 ± 1.33	74.78 ± 3.04
Artemisia absinthium	61.52 ± 1.08	68.25 ± 1.56	75.26 ± 3.12

AC: Ascorbic acid, SD: Standard deviation.

The results of the study were processed by methods of variational statistics using the Student's t-test and presented as the average value ± standard error of the average (M ± m).

Table 8: Superoxide dismutase content in the samples *Artemisia vulgaris and Artemisia absinthium*, mg/g

Object	Specific activity of superoxide dismutase in samples *Artemisia vulgaris and Artemisia absinthium* (mean ± SD)		
	Sample 1	Sample 2	Sample 3
Artemisia vulgaris	0.084 ± 0.009	0.102 ± 0.009	0.133 ± 0.012
Artemisia absinthium	0.101 ± 0.009	0.103 ± 0.009	0.139 ± 0.012

SD: Standard deviation.

Conclusion

Thus, the numerical indicators of moisture and total ash, which characterize the quality of raw materials, have been determined, and differences in the qualitative and quantitative content of macro- and micro-elements, such as potassium, calcium, Na, and Mg and microelements copper, iron, and manganese, have also been established within the two studied objects. Their content corresponds to the containing for MPs.

Analysis of the antioxidant activity of wormwood and common wormwood samples showed that plants are potential sources of antioxidants.

Given the prospects for further medical use of samples of *A. absinthium* and *A. vulgaris*, the information obtained in the work can be useful in predicting possible dosage forms from raw materials.

The obtained data on the content of BAS in the studied samples of wormwood allow a comprehensive assessment of their antioxidant qualities, and species with a high content of analyzed antioxidants are recommended for the collection of plant raw materials as sources of BAS.

The studied samples of common wormwood as products with antioxidant activity can be used as a basis for the producing of innovative food products and products for therapeutic and preventive purposes.

Considering the prospects for further medical use of *A. absinthium* and *A. vulgaris* samples, the information obtained in the work may be useful in predicting possible pharmaceutical dosage forms from raw materials.

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