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A.A. Minkayeva , Sh.M. Mamashev , A.K. Nurlybekova ,
A.A. Kudaibergen , Ye. Shybyray , U. Amzeyeva , J. Jenis*

The Research Center for Medicinal Plants, Al-Farabi Kazakh National University, Almaty, Kazakhstan
*e-mail: janarjenis@kaznu.kz
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Chemical constituents of *Dianthus superbus*, *Matricaria chamomilla* and *Glycyrrhiza glabra*

Abstract. Currently, one of the main directions of science is the study of plants with medicinal properties, the determination of biological activity and its use for medical purposes. In this supplied research work, the quantitative and qualitative composition of phytochemical components of plants *Dianthus superbus, Matricaria chamomilla* and *Glycyrrhiza glabra* growing in the Republic of Kazakhstan were investigated first-ever. The results of our studies showed the maximum amount of organic acids (0.317 %) and flavonoids (0.296 %) in the plant *D. superbus*. The content of extractive substances *M. chamomilla* (30.01 %) and *G. glabra L.* (35.30 %), and the content of polysaccharides is higher in plants *G. glabra L.* (1.475 %) and *D. superbus* (1.434 %). The plant *M. chamomilla* showed good results i n the amount of elements needed daily by the human body, including – K (23.97 mg/g), Na (5.39 mg/g), Mg (2.26 mg/g), Ca (4.31 mg/g) and Fe (0.32 mg/g). The results of the conducted analyses showed that the studied objects contain a sufficient amount of bioactive substances that may enhance the variety of successful home pharmaceuticals in the future based on plant raw materials of the Republic of Kazakhstan.
Key words: *Glycyrrhiza glabra, Dianthus superbus, Matricaria chamomilla*, phytochemical components, macroelements, microelements.

Introduction

Dianthus superbus is well-known traditional herbal medicine recognized for its anti-inflammatory effects in ancient Mongolian and Chinese oriental medicine. Even in the modern day, Mongolians are using *D. superbus* for reducing inflammation and reported to have plentiful with cyclic peptides, which showed strong anticancer activity on a wide range of cancer cells. Additionally, organic extraction of *D. superbus* exhibited antiviral activity against diverse strains of influenza A and B viruses. Moreover, quercetin derivative isolated from *D. superbus* showed stronger anti-influenza activity than the commercial drug Oseltamivir and was found to block viral RNA (vRNA) replication through binding to PB2 subunit of viral polymerase [1].

Matricaria chamomilla has various and ancient uses, including herb tea, natural medicine, and pharmaceutical preparations. It contains anti-inflammatory, antibacterial, anti-allergic effects, acts as a diuretic, sedative, carminative, and secretogog for bile, and is applied externally for healing skin wounds, mouth sores, and haemorrhoids. Chamomile's medical and pharmacological benefits are mostly associated with its essential oil, which has antispasmodic, antibacterial, and disinfectant characteristics. The essential oil of chamomile is widely utilised in the culinary, cosmetics, and pharmaceutical sectors. Chamazulene, epi--bisabolol, -bisabolol oxide, -carvacrol, p-cymene, (E)--ocimene, (Z)--ocimene, (E,E)-farnesol, and en-yn-dicycloethers are the most important therapeutically relevant chemicals found in essential oil. Flavonoids, coumarins, hydroxycinnamic acids, mucilages, and a few other primary metabolites are also pharmacologically active. In vitro, chamomile displayed moderate antibacterial and antioxidant characteristics, as well as considerable antiplatelet activity and tentative anticancer outcomes. Chamomile essential oil was found to be a potential antiviral agent against herpes simplex virus type 2 (HSV-2) in vitro [2].

Glycyrrhiza glabra L. is widely used as a medicinal plant. *Glycyrrhiza* genus of flowering plants of the Fabaceae family, is a flowering native plant to Asia. There are five species growing in

Kazakhstan (Flora Kazakhstan). Phytochemical analysis indicated biologically active complexes of *G. glabra* are triterpene, flavonoids, polysaccharides, simple sugars, amino acids, mineral salts, fat, protein, resins, starches, glycosides, and various other substances. Several research [3, 4, 5, 6] have found that *G. glabra* extract or its derivatives, primarily glycyrrhizin, have expectorant, diuretic, laxative, sedative, antipyretic, antibacterial, and anxiolytic, antiviral, anti-inflammatory, and antioxidant properties. G. glabra has long been used to cure coughs and colds, as well as to soothe upset stomach, whilst diammonium glycyrrhizinate has anti-inflammatory properties and is used to treat liver damage caused by hepatitis B. According to Professor Hong Ding of Wuhan University presented a COVID-19 treatment combining diammonium glycyrrhizinate and vitamin C, and clinical studies have recently been allowed [7].

In this study, medicinal plants *Dianthus superbus, Matricaria chamomilla* and *Glycyrrhiza glabra L.* growing in Kazakhstan were studied for the quantitative content of biological active complexes namely flavonoids, carboxylic acids and polysaccharides for the first time. Comparatively, previous studies showed the results of amino acids and vitamins content from *Chamomilla recutita* (German chamomile) [8]. In the course of the work, the analysis of common biologically active components was carried out, such as the determination of the amount of organic acids, flavonoids, and polysaccharides, moisture content, total ash, and extractive content measured. The multi-element atomic emission spectrum analysis approach was also used to determine the levels of macro- and microelements in ashes and plants.

Materials and methods

Plant material *Matricaria chamomilla* was harvested in Southeast region, foothills of Alatau mountain Kazakhstan in the summer of 2021. Plant material *Glycyrrhiza glabra L.* was collected in in the vicinity of the city of Shardara, Kazakhstan in early autumn 2020. *Dianthus superbus*, *M. chamomilla*, and *G. glabra* L. air-dried parts were chopped into tiny pieces and kept at room temperature.

Methods described in the monograph [9] were used to conduct quantitative and qualitative analyses of bioactive compounds of *D. superbus*, *M. chamomilla*, and *G. glabra* L. A quantitative content of biologically active complexes namely the flavonoids, carboxylic acid and polysaccharides was investigated. The flavonoids content was identified by measuring optical density of the prepared appropriate solution with an application of spectrophotometer at the wavelength of 430 nm. For the determination of polysaccharides the water extraction of plant obtained and combined with 95% ethyl alcohol in the ratio 1:3 and centrifuged at a speed of 4000 rpm for 30 minutes. The supernatant was filtered under vacuum through a glass PORE filter and dried to a constant mass that was calculated to a percentage value. The quantitative determination of carboxylic acids is carried out by titration method. The extractive content of three analyzing plant samples was measured using 80% ethanol solutions in water, as described in the State Pharmacopoeia X [10].

A Shimadzu 6200 series spectrometer was used to identify the mineral composition. In a pre-calcined and precisely weighed porcelain crucible, 3 g of raw material was inserted. The crucible was then slowly heated, first allowing the material to burn at the lowest feasible temperature before gradually increasing the flame. Calcination was carried out at 500°C to get a consistent mass. The crucible was cooled in a desiccator at the end of the calcination, and the resultant ash was burnt again at 600°C until a uniform grey color was achieved. Heating was used to dissolve plant ash in 10.0 mL of 40% nitric acid. The resultant solution was then boiled to produce wet salts. It was subsequently dissolved in 15.0 mL of 1 N nitric acid and transferred to a volumetric flask of 25.0 mL for analysis. Thus, it must be done for each of the three plants.

Results and discussion

Bioactive components, moisture content, total ash, and extractives were quantified and qualitatively analysed in *Dianthus superbus*, *Matricaria chamomilla*, and *Glycyrrhiza glabra* L. The findings are shown in Table 1.

Moisture and ash content vary within specified limitations for each plant and are determined by the nature of the plant material itself, as well as how it is harvested and dried. These data will be required for additional computations throughout the research, therefore determining these contents was required to demonstrate the high quality of *D. superbus*, *M. chamomilla*, and *G. glabra* L.

Using 80% alcohol, the most extractive compounds were extracted from all three plant species. As a result, this appropriate solvent can be employed in extraction. The identification of extractive compounds using an appropriate solvent is critical since the quantity of biological metabolites dictates the plant's quality.

Flavonoids are the most abundant dietary polyphenolic class. They are a varied category of around 4000 distinct physiologically active chemicals synthesised during plant metabolism [11]. Flavonoids may contribute to a number of positive biological actions in humans after ingestion. Strong and consistent evidence currently suggests that flavonoids can maintain and boost nitric oxide status while also improving endothelial function. There is also evidence that these substances can affect blood pressure, oxidative damage, inflammation, platelet function and thrombosis, blood lipids, and glucose metabolism [12, 13]. These actions may assist to explain the results that flavonoids and flavonoid-rich diets have cardioprotective and antineoplastic activities [14, 15].

Organic acids are responsible for the taste, flavour, microbiological stability, and product consistency of plant-derived drinks, and they are employed in food preservation due to their antibacterial properties. Polysaccharides are unique chemicals that may maintain moisture in the dermis, keep the skin elastic, increase collagen fiber synthesis, and boost cell immunity.

Table 1 – Quantitative and qualitative analysis of biologically active constituents of *Dianthus superbus*, *Matricaria chamomilla* and *Glycyrrhiza glabra L.*

Plant Component	*Dianthus superbus*	*Matricaria chamomilla*	*Glycyrrhiza glabra L.*
	Content, %		
Moisture	5.00	6.70	5.10
Ash	6.40	12.68	4.80
Extractives	20.53	30.01	35.30
Organic acids	0.317	0.126	0.071
Flavonoids	0.296	0.105	0.150
Polysaccharides	1.434	0.643	1.475

The results of our research have shown the maximum content of organic acids and flavonoids in the plant *Dianthus superbus*. The content of extractive substances was higher in the plant *Matricaria chamomilla* and *Glycyrrhiza glabra L.*, and the content of polysaccharides was higher in the plants *G. glabra L.* and *D. superbus*. Eleven macro- and microelements were extracted (received) from plant ash. As demonstrated in Table 2, the most common were K, Na, Ca, and Mg. All three plants are an excellent source of minerals and vital elements that are required for the proper functioning of the muscular, cardiovascular, immune, as well as nervous systems and play a role in the synthesis of vital compounds, metabolic procedures, hematopoiesis, digestion, and metabolic product neutralization. The results visually illustrated in Figure 1 and 2 in order to the difference can be seen properly.

Nutrients work in concert to sustain physiologic cellular and tissue processes, and their dysregulation can have a negative impact on organ function [16]. Magnesium is the human body's fourth most prevalent mineral. This vitamin acts as a cofactor or activator in over 600 enzymes and has an effect on extracellular calcium levels. Magnesium is required for optimal physiological processes since it is used in RNA and DNA synthesis, antioxidant level maintenance in the cell, and energy metabolism. Magnesium is found predominantly in bones and teeth (60%) as well as in the intracellular space (40%) [17, 18]. Potassium (K) is the most abundant exchangeable cation in the human body and exists predominantly in the intracellular fluid [19]. It helps regulate fluid balance, muscle contractions, and nerve signals, helps reduce blood pressure (therefore, lower the hypertension rate) and water retention, protects against stroke, and prevents osteoporosis and kidney stones [20].

Dietary calcium shortage has been associated to a number of chronic conditions, including osteoporosis, osteomalacia, hypertension, colon cancer, and obesity, according to epidemiological studies. Calcium is a mineralized tissue component that is essential for appropriate growth and development of the skeleton. Calcium consumption must be optimal in order to maximise adult bone mass growth, maintain it, and prevent bone loss in the elderly. Calcium alone accounts for around 2% of total body weight, with the majority of this being distributed in the bones.

The bones and teeth contain the majority of calcium, around ninety-nine percent [21]. The remainder, or one percent, is found in serum, extracellular fluid, muscles, and other tissues. As a result, getting enough calcium aids in increasing bone metabolism and improving overall bone health [22].

Table 2 – Composition of macro-micro elements in the ash and plant of *Dianthus superbus*, *Matricaria chamomilla* and *Glycyrrhiza glabra L.*

	Dianthus superbus		*Matricaria chamomilla*		*Glycyrrhiza glabra L.*	
Element	Conc. in ash, mg/g	Conc. in plant, mg/g	Conc. in ash, mg/g	Conc. in plant, mg/g	Conc. in ash, mg/g	Conc. in plant, mg/g
K	154.45	9.39	202.58	23.97	328.02	14.95
Na	14.41	0.876	45.52	5.386	9.445	0.4304
Ca	62.15	3.779	36.45	4.313	4.909	0.2237
Mg	30.77	1.871	19.07	2.256	12.605	0.5744
Cu	0.0362	0.0022	0.0786	0.0093	0.0463	0.0021
Cd	0.0017	0.0001	0.0021	0.0002	0.0010	0.00005
Pb	0.0095	0.0006	0.0231	0.0027	0.0109	0.0005
Fe	0.1973	0.0120	2.6972	0.3192	2.0342	0.0927
Mn	3.3276	0.2023	0.3869	0.0458	0.3287	0.0150
Ni	0.0121	0.0007	0.0225	0.0027	0.0126	0.0006
Zn	0.0613	0.0037	0.1414	0.0167	0.2932	0.0134

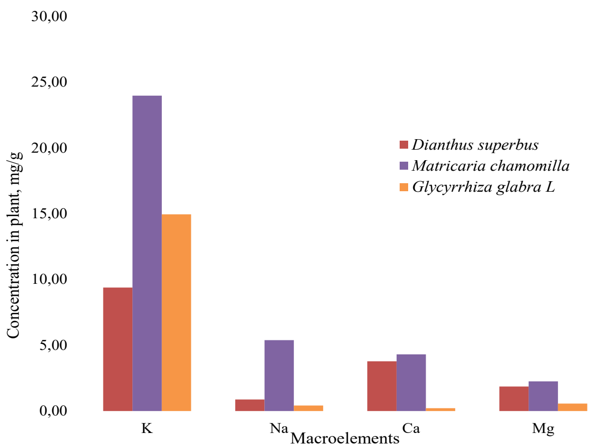

Figure 1 – Composition of macroelements in the plant of *Dianthus superbus*, *Matricaria chamomilla* and *Glycyrrhiza glabra L.*

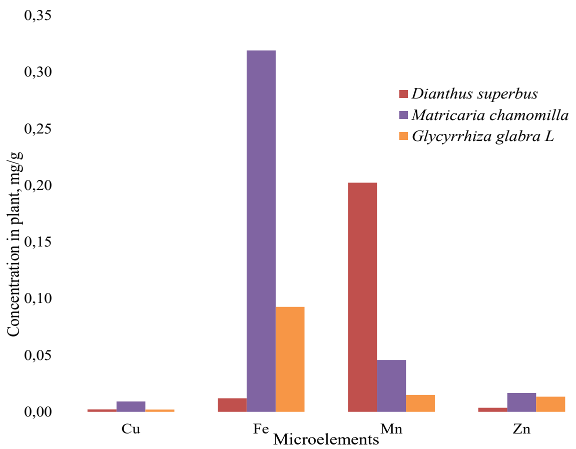

Figure 2 – Composition of microelements in the plant of *Dianthus superbus*, *Matricaria chamomilla* and *Glycyrrhiza glabra L.*

As a result of our research, it was found that in the studied plants from macronutrients K, Na, Mg, Ca predominate, and from trace elements a high content of Cu, Fe, Zn, Mn. Thus, all three tested plants can be considered as potential sources of trace elements, which in the future may allow to expand the scope of application of this plant raw material.

Conclusion

Within the framework of the project AP09259567 "Multi-natural additive suppressing the spread of acute respiratory viral infections in humans", a quantitative analysis of the plants *Dianthus superbus, Matricaria chamomilla* and *Glycyrrhiza glabra L.*, which were collected on the territory of the Republic of Kazakhstan, was carried out, which may claim the presence of these biological active complexes as a qualitative indicator. During the study, the total number of biologically active components and the content of macro-, microelements of plant raw materials were established. It is particularly worth noting that the chamomile showed excellent results in the amount of elements needed daily by the human body (K, Na, Mg, Ca). The identified substances from the three plants have medicinal properties, thanks to which these plants can be used for the prevention of leukemia and other blood diseases, in the manufacture of medicines against diseases of the gastrointestinal tract, urinary tract, lungs, respiratory organs and reproductive system. Since the composition is rich in useful substances, the quantitative and qualitative analysis of these plants will be continued in the future.

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