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DETERMINATION OF MACRO- AND MICROELEMENT COMPOSITION IN THE SEEDS OF ARTICHOKE (*CYNARA SCOLYMUS* L.) AND MILK THISTLE (*SILYBUM MARIANUM* L.)

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Annotation

The seeds of artichoke *(Cynara scolymus* L.) and milk thistle (*Silybum marianum* L.) possess a distinctive chemical composition and contain a variety of beneficial macro- and microelements. In this study, the mineral composition of artichoke and milk thistle seeds cultivated under local conditions was determined using inductively coupled plasma optical emission spectrometry (ICP-OES). The results revealed a significant presence of essential elements involved in the metabolism of biologically active compounds, such as P, K, Ca, Mg, Na, Fe, Zn, Cu, Mn, Al and others. The obtained data justify the potential use of these plant seeds as raw materials for the development of biologically active supplements, as well as for applications in the pharmaceutical and dietary industries.

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Introduction. Artichoke (*Cynara scolymus* L.) and milk thistle (*Silybum marianum* L.) are medicinal plants that have been widely used in traditional medicine since ancient times. Both species are distinguished by their therapeutic properties and unique biologically active compounds [1–2]. Modern scientific studies, including analyses of the mineral composition of artichoke and milk thistle, have demonstrated the presence of essential macro- and microelements in these plants. Their chemical

composition expands their potential use in the pharmaceutical industry and in the production of natural remedies. In addition, their importance in folk medicine and clinical applications is steadily increasing.

Literature review: The artichoke (*Cynara scolymus* L.) occupies an important place in folk medicine and modern healthcare due to its biologically active chemical composition. Its leaves and seeds contain active compounds such as cynarin, caffeoylquinic acid, and luteolin, which support various physiological functions in the human body [3]. These properties make artichoke not only a medicinal plant, but also an effective agent for improving liver and heart health [4].

The chemical composition of milk thistle (*Silybum marianum* L.) seeds includes flavonoids, alkaloids, unsaturated fatty acids, various vitamins, and numerous macro- and microelements. These components enhance the plant's value in both traditional and modern medicine. One of the main compounds in milk thistle is the flavonoid silymarin, known for its strong antioxidant and anti-inflammatory effects. Silymarin has proven effective in treating chronic hepatitis, liver cirrhosis, and even cancer. Its antioxidant properties help detoxify the liver and reduce liver cell inflammation, thus promoting liver health [5].

Preparations based on raw materials of artichoke and milk thistle are prescribed mainly for the treatment and prevention of acute and chronic hepatitis, toxic liver damage, nephritis, liver cirrhosis, and many other conditions [6].

The chemical composition of artichoke and milk thistle leaves includes not only biologically active compounds, but also numerous macro- and microelements. The seeds of artichoke contain macroelements such as Na, K, Ca, Mg, and P, and microelements like Zn, Cu, Mn, Se, and Fe. These elements contribute to the antioxidant and anti-inflammatory properties of the plant and improve physiological functions in the body [7].

Analyses of the seeds of these studied plants revealed the presence of several macro- and microelements with biological significance. These elements are part of biologically active compounds that regulate important physiological processes in the human body. Chemical elements, particularly in ionic form, play a role in generating bioelectrical activity in living tissues (biopotentials). Such bioelectrical phenomena, observed in the brain, nervous tissues, cardiovascular and gastrointestinal systems, and muscles, are directly influenced by the balance of cations and anions. This balance is essential for maintaining excitability and transmission of impulses in the body [8].

Experimental section and discussion of results: To determine the amount of macro- and microelements in the seeds of medicinal milk thistle (*Silybum marianum* L.) and artichoke (*Cynara scolymus* L.), 1 g of dried and ground seed sample was weighed using a 0.001 g precision scale (Navigatortm, OHAUS®) and incinerated in a porcelain crucible in a muffle furnace (Nabertherm, Germany) at 500°C using the dry ashing method [9].

The experiment was conducted using the iCAP PRO X Duo ICP-OES (Inductively Coupled Plasma Optical Emission Spectrometer) manufactured by Thermo Fisher Scientific (USA). Method development and data analysis were performed using Qtegra ISDS software.

The concentrations of macro- and microelements found in the seeds of milk thistle and artichoke are presented in Table 1.

Table 1. Results of the determination of chemical elements in the composition of the samples by the ICP-OES method (mg/100 g)

№	Macro- and microelement name	Milk thistle seed	Artichoke seed	№	Macro- and microelement name	Milk thistle seed	Artichoke seed
1	P	959776,16±3111,22	885385,17±6876,06	21	Ga	23,93±10,31	11,43±5,81
2	Sn	694,22±3,61	740,59±5,35	22	V	76,03±6,26	61,33±7,34
3	Se	63,28±20,44	62,77±15,87	23	Be	1,49±0,15	1,58±0,04
4	Mo	152,41±0,62	154,2±2,4	24	Er	0,02±7,22	5,82±0,12

5	Zn	5574,84±13,81	6505,44±61,89	25	Cu	1906,54±4,59	2197,62±12,24
6	Pb	23,49±5,33	27,22±3,54	26	In	81,42±8,02	39,12±21,14
7	Ni	157,81±1,89	152,32±1,4	27	Ag	15,17±3,03	23,69±5,62
8	Ir	32,3±12,41	44,55±2,52	28	Yb	0,06±0,4	0,14±0,2
9	Cd	15,35±0,41	22,55±2,15	29	Ti	176,72±7,63	138,77±2,13
10	W	27,51±15,19	8,71±37,1	30	Rh	41,78±3,71	30,35±1,67
11	Au	76,26±19,96	72,85±10,13	31	Sc	1,29±0,11	1,38±0,17
12	B	1250,37±3,62	1460,04±13,26	32	Ca	14952,46±139,54	15131,17±97,6
13	Si	1899,71±7,96	1860,81±14,11	33	Al	2195,22±19,46	1771±6,91
14	Mn	3530,18±19,85	2965,45±7,91	34	Sr	2076,3±115,92	3073,4±54,58
15	Fe	8293,98±20,73	7892,66±67,86	35	Ce	129,42±15,74	136,58±13,06
16	Lu	0,24±0,08	0,77±0,2	36	Ba	781,89±5,33	672,02±5,76
17	Mg	388730,01±918,45	376450,81±5711,24	37	Na	13974,43±175,64	14942,58±314,93
18	Th	171,17±11,63	153,99±4,79	38	Li	15,09±0,07	109,76±0,64
19	Cr	396,78±4,35	415,54±4,054	39	K	603760,67±2932,35	611818,51±4389,17
20	Sn	218,39±13,14	222,72±11,27	40	Ga	23,93±10,31	11,43±5,81

The seeds of Silybum marianum and Cynara scolymus were found to contain more than 40 macro- and microelements. In particular, the predominant macroelements in Silybum marianum seeds were identified as P > K > Mg > Na > Ca, and a similar order was observed in Cynara scolymus seeds. Among the microelements, the most abundant were Fe > Zn > Mn > Al > Sr > Cu, along with several others. Recent studies show that the seeds of these plants are rich in essential micro- and macroelements necessary for the human body. However, a comparative analysis of the elemental composition of the seeds and their potential health benefits remains insufficiently explored.

The seeds of milk thistle (*Silybum marianum*) and artichoke (*Cynara scolymus*) contain high levels of elements such as phosphorus (P), magnesium (Mg), zinc (Zn), manganese (Mn), copper (Cu), and selenium (Se). These elements contribute to the stabilization of liver cell membranes, the maintenance of mitochondrial functions, and antioxidant protection. The hepatoprotective properties of silymarin and cynarin compounds have been confirmed in scientific literature [10–12].

A high content of potassium (K) and sodium (Na) plays an important role in kidney function and in maintaining the body's water-salt balance. These elements also participate in the regulation of blood pressure [13].

Magnesium, potassium, copper, and iron are essential for regulating heart rhythm, oxygen transport, and the transmission of nerve impulses. Lithium (Li) levels are particularly high in artichoke, and under controlled use, it may exhibit neuroprotective effects.

Selenium, zinc, manganese, and copper are involved in the activity of antioxidant enzymes such as glutathione peroxidase and superoxide dismutase. Furthermore, the phenolic compounds present in the seeds enhance their anti-inflammatory properties [14].

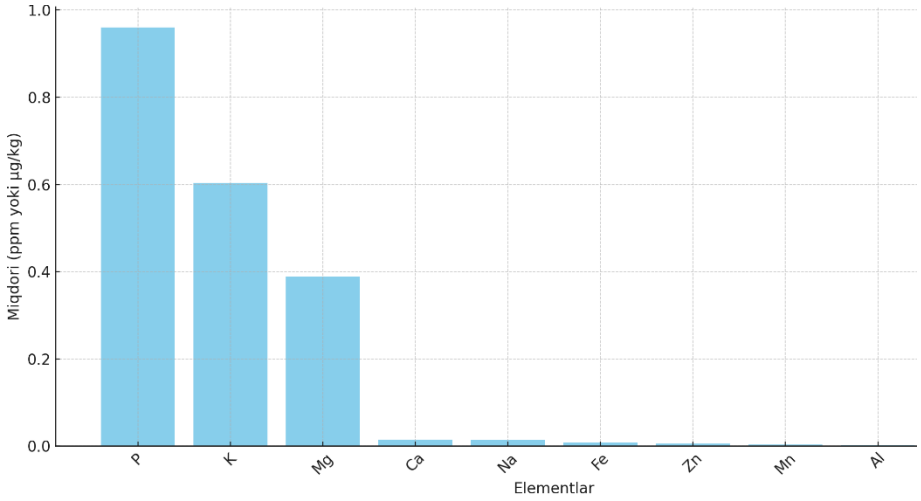


Figure 1. The content of macro- and microelements in the seeds of Silybum marianum and Cynara scolymus.

Conclusion. The main objective of this study was to determine the content of macro- and microelements in the seeds of *Cynara scolymus* L. (artichoke) and *Silybum marianum* L. (milk thistle), and to assess their biological significance. The obtained results show that these plants contain essential bioelements such as phosphorus (P), potassium (K), and magnesium (Mg), which play a crucial role in important biochemical processes in the human body.

Specifically, phosphorus is involved in energy metabolism, maintaining cell membrane stability, and transmitting neuromuscular impulses. Potassium plays a key role in regulating cardiac muscle function and maintaining blood pressure. Magnesium is important for the proper functioning of the nervous system, cardiovascular system, muscles, bone tissue, and metabolic processes.

Furthermore, artichoke and milk thistle are rich in polyphenols, unsaturated fatty acids, antioxidants, and various vitamins, making them valuable raw materials for the development of hepatoprotective and functional food supplements.

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