ANALYSIS OF MACRO AND MICRO ELEMENTS OF *Morus alba*

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ABSTRACT. As a result of the study of the mineral composition of the leaves, fruits and seeds of the Morus alba plant, the amount of 44 elements was determined using optical emission spectrometry with inductively coupled plasma. It was found that the amount of macroelements calcium, magnesium, potassium, sodium, phosphorus and sulfur and microelements manganese, iron and zinc is higher compared to other elements.

Keywords: macro- and microelements, inductively coupled plasma mass spectrometer.

Introduction. The mulberry (Morus) belongs to the Moraceae family and is a genus of fruit-bearing trees. In Uzbekistan, five species of mulberry grow. The fruits of the white mulberry (M. alba) and black mulberry (M. nigra) are edible. Other species, such as the multi-branched mulberry (M. multicaulis), Kagayama mulberry (M. kagayama), and silkworm mulberry (M. bombycis), are mainly used for silkworm breeding [1]. Mulberry trees grow rapidly and are resistant to drought and cold. They have dense branches with broad, rounded, oval, or pyramid-shaped crowns. The tree reaches a height of 15–18 meters, with some specimens growing up to 20–25 meters, and trunk thickness reaching up to 1.5 meters. Mature, tall mulberry trees can yield 20–40 kg of leaves and 50–60 kg of fruit per season. There are also twisted and downward-growing varieties, known as weeping mulberry. Some mulberry trees live up to 300 years, while certain specimens can survive for 500 years. Distribution of Mulberry Varieties Worldwide. There are 20 species of mulberry trees found across the world, primarily in East and Southeast Asia, India, Africa, and the temperate and subtropical regions of North America [2]. Many mulberry varieties grow in China. The white mulberry (M. alba) originates from China, while the black mulberry (M. nigra) originates from Iran and Afghanistan [3]. Mulberry fruit has a high water content, ranging from 82.9% to 86.2%. Additionally, it is a juicy fruit, containing 10.9% to 12.7% sugar. When dried, the sugar concentration increases significantly. Dried mulberries contain 73.29% to 83.71% sugar. Besides being a natural sweetener, mulberries are rich in vitamins B, C, E, K, and PP [4].

Chemicals. Chemically pure reagents were used in the experiments. Multi-element standard for MS (29), multi-element standard for MS (rare metals), standard - Hg (mercury), purified nitric acid (puriss.), hydrogen peroxide (puriss.), deionized water, argon (purity level 99.995%) [5].

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*Sample preparation for analysis.*0.1000 g was quantitatively transferred into Teflon autoclaves. 3 ml of purified concentrated nitric acid and 2 ml of purified hydrogen peroxide were added to it. The autoclave was sealed and placed in a microwave Berghof (Speed Wave Xpert) digester. In this case, a command was given to decompress on the basis of a known program in the device interface [6]. In this method, the device automatically controls the number of autoclaves and the temperature and pressure inside them. Information about the process is monitored through a liquid crystal display [7]. It was carried out in wet decomposition for 35-45 min in autoclaves with minimum temperature T (50^0C) and maximum temperature T (230^0C), pressure P [bar] max 40 [bar].

The autoclaves were cooled to room temperature and the liquid mixture inside was quantitatively transferred to a 50 mL volumetric flask (to the mark). In this case, the autoclaves were rinsed 2-3 times and then filled to the line of the flask with bidistilled water [8]. The solution was thoroughly mixed and put into the autosampler test tube and placed in the autosampler at a certain numbered place. In the program, the location of each test tube, the withdrawn mass and the dilution factor are entered (so that the device can automatically calculate the concentration).

The mineralized solution was quantitatively analyzed in the Avio-200 (ICP-OES) inductively coupled plasma optical emission spectrometer of the Perkin Elmer company, compared to the standard sample containing the amount of macro and microelements, heavy metal salts, and rare metals [9]. Assay results automatically calculate precision and standard deviation (RSD) values by recalculating results based on sample mass and dilution values at the end of the process.

Preparation of the Object for Analysis: The mineral composition of the Morus alba plant was studied using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). The concentration of macro- and microelements in the leaves and fruit of the plant was determined. A total of 44 elements were analyzed in the plant's composition. The highest mineral content was found in the fruit, reaching 76,871.219 mg per 10 g (Table 1) [10].

Table 1

Mineral Composition and Quantity of Morus alba (mg/10 g)

№	Elements	*Mineral Composition and Quantity of Morus alba (mg/10 g)*	
		Leaves (mg/10 g)	Fruit (mg/10 g)
1 (7)	Li	0.447	2.488
2 (9)	Be	0.015	0.021
3 (11)	B	32.038	71.203
4 (23)	Na	157.000	4599.156
5 (24)	Mg	1832.401	22569.621
6 (27)	Al	72.409	151.912
7 (28)	Si	278.163	378.057
8 (31)	P	22.409	34.912

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9 (32)	S	55.576	126.358
10 (39)	K	5009.326	76871.219
11 (42)	Ca	37171.738	47099.057
12 (48)	Ti	16.966	41.706
13 (51)	V	0.045	0.863
14 (52)	Cr	0.500	6.171
15 (55)	Mn	10.764	142.637
16 (57)	Fe	756.539	9982.923
17 (59)	Co	0.088	0.627
18 (60)	Ni	0.866	4.797
19 (63)	Cu	2.927	118.608
20 (66)	Zn	8.616	686.076
21 (69)	Ga	0.210	0.252
22 (74)	Ge	0.004	0.044
23 (75)	As	0.110	3.360
24 (82)	Se	0.301	1.358
25 (85)	Rb	2.646	5.003
26 (88)	Sr	81.479	41.730
27 (90)	Zr	0.055	0.266
28 (93)	Nb	0.005	0.042
29 (98)	Mo	0.349	0.042
30 (107)	Ag	0.003	0.021
31 (111)	Cd	0.003	49.328
32 (115)	In	0.002	0.001
33 (118)	Sn	15.729	9.732
34 (121)	Sb	0.003	0.374
35 (133)	Cs	0.011	0.033
36 (138)	Ba	4.254	4.369
37 (181)	Ta	0.009	0.007
38 (184)	W	0.001	0.182
39 (187)	Re	0.004	0.010
40 (202)	Hg	0.252	0.498
41 (205)	Tl	0.002	0.003
42 (208)	Pb	0.128	311.590
43 (209)	Bi	0.001	0.019
44 (238)	U	0.048	0.062

The macroelement content in the mineral composition of Morus alba was 5,009.326 mg/10 g in the leaves and 76,871.219 mg/10 g in the fruit. The decreasing order of macroelements in both leaves and fruit follows the same pattern: K > Ca > Mg > Na > S > P. The elements potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), fluorine (F), and sulfur (S) were identified in Morus alba [11]. Among all the samples, potassium and calcium had the highest concentrations. In the leaves,

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calcium was dominant, whereas in other plant organs, calcium levels were relatively higher. The calcium content in different plant organs followed this order: fruit > leaves. The highest concentration of calcium was found in Morus alba, with a 1:1.5 ratio of calcium across different plant parts [12].

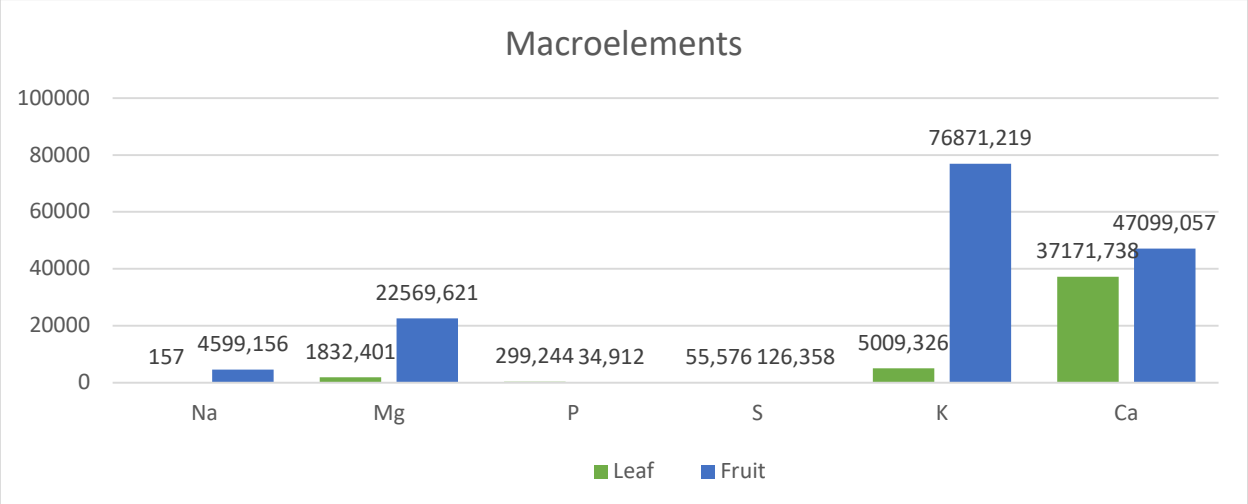


Figure 1. Macroelement Content in Morus alba (mg/10 g)

The mineral composition analysis of Morus alba identified the presence of 44 microelements. The concentration of microelements follows a decreasing order: fruit > leaves. Other microelements were found in lower concentrations (Figure 2) [13].Iron and Vanadium Content in Morus alba. The iron (Fe) content in the plant decreases in the following order: fruit > leaves. The concentration of vanadium (V) varied across different plant organs, ranging from 6 to 41. Silver (Ag) was either absent or detected in extremely low amounts [14]. The iron content in Morus alba was determined to be 9,982.923 mg/10 g in the fruit and 756.539 mg/10 g in the leaves. The potassium-to-iron ratio in Morus alba was 255:1 in the leaves and 4.66:1 in the fruit. Meanwhile, the calcium-to-iron ratio in the plant was 30:1 [15].

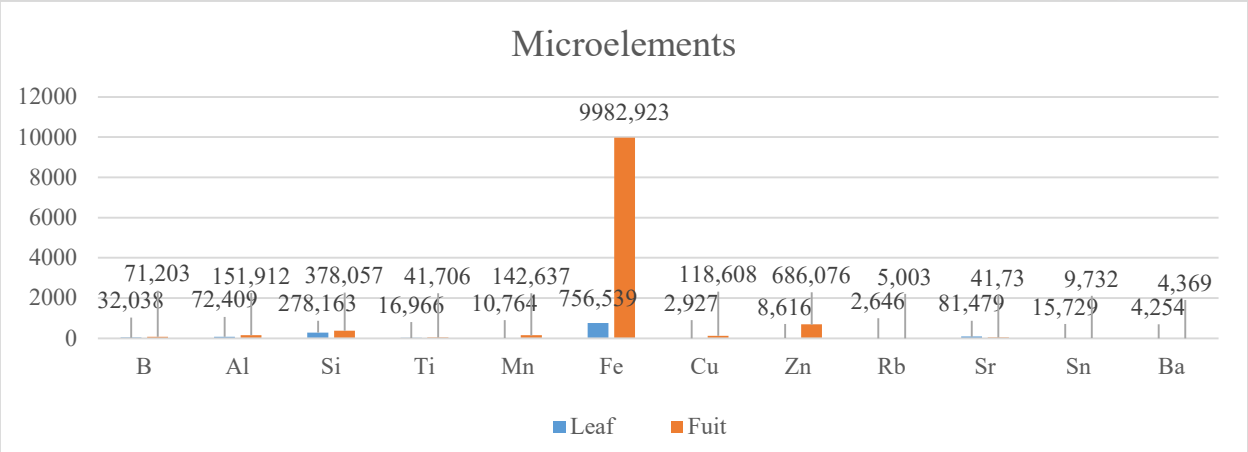


Figure 2. Microelement Content in Morus alba (mg/10 g). The presence of toxic elements such as lead (Pb), mercury (Hg), uranium (U), and arsenic (As) in Morus alba was analyzed. Arsenic was detected in the bulb and flower of the plant (Table 3). Lead was found in the fruit at 311.590 mg/10 g and in the leaves at 0.128 mg/10 g. However, no prior studies have provided information about toxic elements in

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Morus alba [16]. The number of elements identified in Morus alba was nearly the same as in other similar plant species, but it stood out due to the high concentrations of both macro- and microelements.

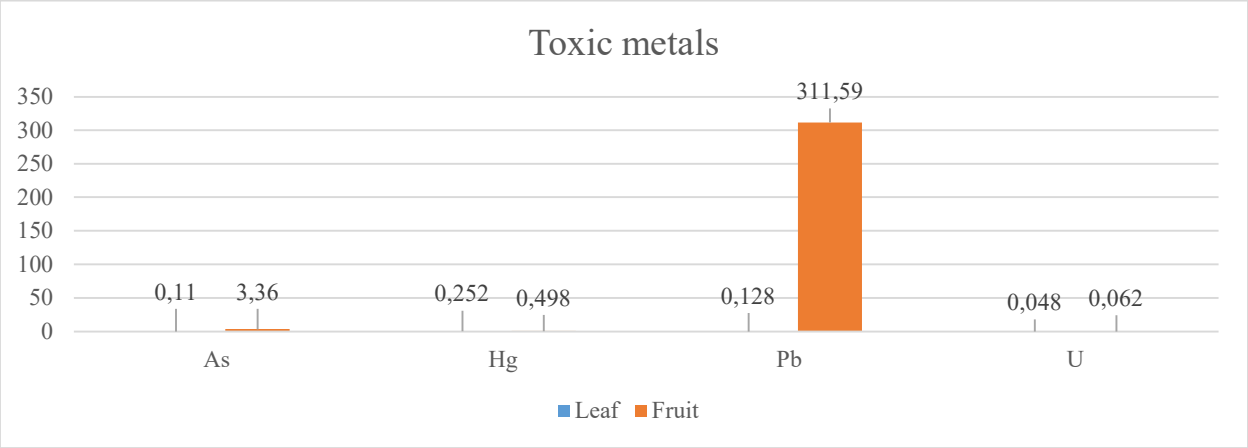


Figure 3. Toxic Element Content in Morus alba (mg/10 g)

Conclusion. The mineral composition of Morus alba was analyzed using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES), identifying 44 elements in the leaves and fruit. Among the different plant organs, calcium (Ca) had the highest concentration. Among the microelements, manganese (Mn), iron (Fe), and zinc (Zn) were found in higher amounts compared to other elements. Given its rich mineral content, Morus alba can be utilized in the production of various biologically active supplements and medicinal preparations.

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