

QUANTIFICATION OF ESSENTIAL ELEMENTS IN PAPAVER RHOEAS L. AND PAPAVER SOMNIFERUM

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Abstract:

Plants are very important for proper human nutrition, so the content of essential elements was investigated in two poppy species. Essential elements such as Ca, Na, K, Mg, Fe, Cu, Co, Mn, Mo and Zn play a vital role in various biological processes. Samples of roots, stems, leaves and seeds of *Papaver rhoeas L.* and *Papaver somniferum* were acid dissolved and analyzed by inductively coupled plasma optical emission spectrometer (ICP-OES). The highest concentration of Ca was contained in leaf samples ML1 and ML2 with values of 38618.90 and 33320.15 mg/kg, the root of *Papaver rhoeas L.* had the highest concentration of Na with a value of 1651.07 mg/kg, while the leaf had the highest concentration of Mg of 4400.04 mg/kg. The leaf *Papaver somniferum* contains the highest concentration of K with a value of 61595.90 mg/kg, the root samples MK1 and MK2, both poppies had the highest Fe of 1254.21 and 1620.16 mg/kg. Seeds of both poppies, *Papaver rhoeas L.* and *Papaver somniferum*, contain the highest concentration of Cu with values of 30.57 and 22.20 mg/kg, Mn with values of 71.99 and 58.10 mg/kg and Zn with values of 76.99 and 82.09 mg/kg. The Co content in all samples was low.

Key words: *Papaver rhoeas L.*, *Papaver somniferum*, essential elements, ICP-OES, nutrition

1. Introduction

Wild poppy, meadow poppy, red poppy all are synonyms for the plant under the scientific name *Papaver rhoeas L.* Wild poppy is an annual plant from the poppy family (lat. *Papaveraceae*). Its tree is branched, and the stem and leaves are covered with trichomes [1]. The fruit pod can contain several hundred to a thousand small seeds, black, brown or gray in color. The only species from the *Papaveraceae* family that is grown as a field crop is *Papaver somniferum*, opium poppy. *Papaver somniferum* is an annual plant [1]. The poppy itself is grown for seeds under the control of the International Narcotics Control Board within the UN and World Anti-Doping Agency [2]. All parts of the plant are poisonous except for the seeds, which are used in the diet. One hundred grams of poppy seeds can contain 40.8 g of fat, 19.5 g of protein, 28.7 g of carbohydrates and 10 g of dietary fiber [1, 3]. This seed is extremely rich in vitamin C, E and B complex vitamins (niacin, riboflavin, folic acid), which act as important cofactors in fat and carbohydrate metabolism [1, 3]. It is also rich in important minerals that are easy to use. The human body needs about 20 essential elements in order to function properly, and among them are the 10 metals determined below. Based on today's knowledge, it has been concluded that metals such as Na, K, Mg, Ca, Fe, Mn, Co, Cu, Zn and Mo are very important elements for the proper development of living beings. Accordingly, appropriate amounts of these metals

must be entered [4]. In essence, any essential element can potentially be toxic if the dose is high enough [5, 6]. The role of these essential elements is diverse. Almost all biological polymers and macromolecules such as membranes, ribosomes, DNA, RNA, lipids, etc. are negatively charged. Accordingly, Na^+ , K^+ , Mg^{2+} can neutralize negative forms of biomolecules *in vivo*. Also, Ca^{2+} and Mg^{2+} participate in the process of bio-mineralization, because they interact with negatively charged phosphate residues in the double helix of DNA, and thus reduce the electrostatic repulsion between nucleotides. Some metals (Fe^{2+} , Fe^{3+} , Cu^+ , Cu^{2+} , Mn^{2+} , Mn^{3+} , Mn^{4+} , Mo^{4+} , Co^+ , Co^{2+}) play a role in redox reactions where electron transfer occurs [6, 7]. Zinc is a crucial metal that is part of many enzymes, such as: carboxy anhydrase, superoxide dismutase, alkaline phosphatase and others [8]. Manganese superoxide dismutase (MnSOD), glutamine synthetase, arginase, are enzymes that contain Mn [9]. There is no precisely defined recommended amount of these elements, as different authors and organizations define similar but different boundaries [10, 11]. The aim of this research work is to examine the roots, stems, leaves and seeds, opium and meadow poppies, for the content of essential major and trace elements. Various instrumental techniques can be used to determine the content of essential elements. ICP-OES (Inductively coupled plasma - optical emission spectrometry) is an instrumental technique that is often used to determine the elements in the seed, root, stem and leaves of a plant after digestion with strong acids.

2. Materials and methods

Plant material was collected during the summer period in Podgorac (Republic of Serbia). The plants were harvested whole, then washed with distilled and ultra-pure water. The samples were then delivered to the laboratory where individual plant parts (root, stem and leaf) were mechanically chopped with a scalper and dried for 96 hours at 60°C (Iskra Zemun S3, Serbia). After drying, the samples were milled to a fine powder in a ring mill (Herzog, Germany). After drying and milling, root, stem, leaf and seed samples (Table 1) were microwave acid digested (Ethos 1, Milestone) by USA EPA Method 3052, using nitric acid (67% HNO_3 , JT Baker) and hydrogen peroxide (30% H_2O_2 , Marcon Fine Chemicals).

Table 1. Laboratory code name of the analyzed poppy samples

<i>Papaver rhoëas L.</i>		<i>Papaver somniferum</i>	
MK1	Root	MK2	Root
MS1	Stem	MS2	Stem
ML1	Leaf	ML2	Leaf
MP1	Seed	MP2	Seed

ICP-OES (SPECTRO ARCOS, Germany) with an autosampler (ASX-500, Teledyne Cetac Technologies) was used for sample analysis. The lines with the most sensitive wavelength were used for the analysis.

3. Results and Discussion

In Table 2 are shown results of the total content of major (Ca, Mg, Fe, Na and K) and trace elements (Cu, Co, Mn, Mo, Zn) in individual parts of *Papaver rhoëas L.* and *Papaver somniferum*.

The quantified essential elements varied depending on the species and parts of the poppy. According to the obtained results in the root MK1 and MK2, stem MS1 and MS2, the highest content of K was determined, while Co was the least represented. Seed samples contained the most Cu, Mn and Zn. Also, seed samples were rich in Ca and Na. The quantified amounts of essential elements in the examined poppy seed samples were similar to the results obtained in Senilas [12] and Özcans [13] research. If we compare the content of Ca, K, Mg in the seed samples, which we analyzed, with previous research [12, 13], it was noticed that the Ca content was significantly higher in the samples we analyzed and the same level of K and Mg concentrations. Seed samples of both poppy species that we analyzed had a lower Na content, but a higher Fe content compared to Senilas [12] and Özcans [13] studies. The Mn content in the seed samples is close to previous studies [12, 13], while the samples we analyzed contain more Cu and Zn. Both type of poppy seeds, samples MP1 and MP2, were richer in essential elements than Turkish poppy seeds analyzed by Azcan [14]. The observed differences in the amounts

of essential elements for these two poppy species can be attributed to various factors such as the bioavailable concentration of the elements in the soil, the genetic composition, the physico-chemical characteristics and the pH value of the soil. If we compare the obtained results with the results from the USDA database (United States Department of Agriculture, 2020-2021) [15], it could be seen that the samples MP1 and MP2 contained a higher concentration of Ca, Cu, Fe, Mn and Zn, while the content of Mg, K and Na in the analyzed samples was similar and lower.

Table 2. Quantified concentration in mg/kg of dry mass \pm standard deviation for the total content of major and trace elements in individual parts of *Papaver rhoëas L.* and *Papaver somniferum*

Sample	Major elements				
	Ca	Na	K	Mg	Fe
MK1	7028.66 \pm 49.59	1651.07 \pm 22.94	30419.43 \pm 27.82	1641.09 \pm 4.24	1254.21 \pm 67.50
MK2	4419.14 \pm 8.54	312.17 \pm 8.79	33492.34 \pm 220.65	1038.99 \pm 39.32	1620.16 \pm 57.85
MS1	9730.99 \pm 53.51	103.61 \pm 3.04	29261.98 \pm 98.18	1657.43 \pm 37.61	337.07 \pm 19.38
MS2	10294.55 \pm 19.36	51.51 \pm 0.80	32721.85 \pm 88.81	2075.55 \pm 1.41	413.15 \pm 2.68
ML1	38618.90 \pm 170.98	112.41 \pm 3.21	38437.05 \pm 223.52	4400.04 \pm 18.10	721.70 \pm 15.07
ML2	33320.15 \pm 180.24	58.84 \pm 5.45	61595.90 \pm 450.29	3007.46 \pm 3.89	539.09 \pm 1.89
MP1	23402.89 \pm 183.88	88.29 \pm 3.35	7395.84 \pm 19.26	3057.47 \pm 35.69	303.82 \pm 23.33
MP2	19063.49 \pm 77.41	58.51 \pm 2.79	5330.68 \pm 32.31	2806.96 \pm 6.95	203.37 \pm 1.58
Sample	Trace element				
	Cu	Co	Mn	Mo	Zn
MK1	14.29 \pm 0.76	0.399 \pm 0.00	34.64 \pm 0.37	4.62 \pm 0.30	28.95 \pm 0.36
MK2	16.90 \pm 0.05	0.501 \pm 0.01	28.64 \pm 1.21	3.25 \pm 0.22	25.38 \pm 0.04
MS1	9.39 \pm 0.37	0.095 \pm 0.01	15.42 \pm 0.16	1.85 \pm 0.21	20.48 \pm 0.39
MS2	6.70 \pm 0.39	0.142 \pm 0.00	12.05 \pm 0.09	2.64 \pm 0.02	18.93 \pm 0.13
ML1	14.40 \pm 0.22	0.231 \pm 0.00	33.26 \pm 0.25	4.05 \pm 0.15	65.15 \pm 0.60
ML2	11.06 \pm 0.76	0.221 \pm 0.00	35.09 \pm 0.10	4.78 \pm 0.04	61.48 \pm 0.04
MP1	30.57 \pm 0.25	0.143 \pm 0.00	71.99 \pm 1.31	1.13 \pm 0.01	76.99 \pm 0.94
MP2	22.20 \pm 2.28	0.174 \pm 0.01	58.10 \pm 3.15	1.38 \pm 0.03	82.09 \pm 0.15

4. Conclusions

Based on the obtained results, different distribution of essential major and trace elements were observed in different parts of *Papaver rhoëas L.* and *Papaver somniferum*. Major essential elements dominated in the root and leaf samples. It can also be noticed that the seeds are richest with minerals in relation to other parts of the examined poppy species, also seeds contain the highest concentration of Cu, Mn and Zn. By comparing the obtained results with the RDIV [10] it can be concluded that consuming the seeds of both species of poppies satisfies the daily nutritional need for essential trace elements.

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