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Evaluation of the physicochemical composition of aqueous plant extracts

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Abstract. Despite the wide availability of raw materials, scientific data on the physicochemical properties of aqueous extracts of many promising plants remain limited. Most studies focus on alcoholic or combined extracts, whilst aqueous extracts are often considered only in the context of traditional medicine. The aim of this study was to determine the protein and mineral composition of aqueous extracts from selected medicinal plants and to evaluate their potential as sources of functional ingredients for the food industry. Aqueous extracts were prepared from 12 types of plant materials, including *Laminaria* (Elamin), cherry leaves and twigs, liquorice root, rosemary leaves, dill (leaves and seeds), chamomile, angelica root, beggarticks, fireweed, and stevia, using the method developed by V. Filatov. The physicochemical analysis involved the determination of total protein, albumin, calcium, phosphorus, magnesium, potassium, and zinc using a biochemical analyser. The results demonstrated significant variability in protein (1.31-17.54 g/L) and mineral content depending on the botanical origin of the raw materials. The highest protein concentrations were found in extracts from rosemary, stevia, beggarticks, and fireweed leaves. Laminaria extract showed the highest potassium content, whilst rosemary extract had the highest zinc content. Chamomile, angelica, and fireweed extracts also exhibited high levels of essential microelements, particularly phosphorus and zinc. All samples showed significantly higher concentrations of bioactive compounds compared to tap water, confirming the efficacy of the extraction method. The findings support the feasibility of using such extracts to enrich functional dairy products

Keywords: protein content; mineral composition; functional ingredients; functional dairy products; plant enrichment

Introduction

In the context of growing demand for natural and safe ingredients in the food, pharmaceutical and cosmetic industries, aqueous plant extracts are of particular importance as sources of biologically active compounds. The effectiveness of aqueous extracts is largely determined by their physicochemical characteristics, such as pH, dry matter content, acidity, redox potential and polyphenol concentration. These indicators can vary significantly depending on the type of plant raw material, the morphological part of the plant and extraction conditions, which complicates the standardisation and prediction of their functional properties. In this context, the study of the physicochemical parameters of aqueous plant extracts is both relevant and necessary to justify their rational use in the development of functional products and biotechnological solutions. According to I. Matasar *et al*. (2021), the dietary intake of the examined population group was found to be unbalanced in terms of macroelement supply. The diets were deficient in calcium (Ca) and magnesium (Mg) and exhibited disturbances in the optimal ratio between macroelements, which may lead to the development of premorbid conditions and contribute to the onset of nutritional and diet-related diseases. Nutrition is essential for human development, especially in children. Proper nutrition is required for optimal growth to ensure adequate intake of macronutrients and micronutrients, which are vital for healthy childhood development. G. Savarino *et al*. (2021) note that key micronutrients in this regard include zinc, iron, vitamin D, and folic acid.

Recent scientific studies on the metabolism and biological role of zinc in the human and animal body have indicated that the biological function of zinc is largely realised through its participation in the synthesis and stabilisation of nucleic acids and proteins, energy metabolism, cell proliferation and differentiation, and the maintenance of antioxidant status. D. Jin *et al*. (2024) demonstrated that zinc also plays a protective role in the presence of various pathogenic factors. R. Tedesco *et al*. (2021) reported that a total of 261 whey samples were collected and analysed from four locations in the Veneto region of north-eastern Italy. It was found that the whey samples contained a wide range of concentrations of 17 trace elements (0.06-1,530 μg/kg) and 14 rare earth elements (0.16-28.2 μg/kg), but none reached toxic levels. This provides valuable information about the quality of dairy products and, since it reflects local environmental conditions, also serves as an excellent indicator of their geographical origin. The concentrations of 12 non-essential trace elements (Pb, Cd, Hg, As, U, Cr, Sr, Be, Ni, Al, Sn, and Tl) and 8 essential trace elements (Fe, Cu, Mn, Zn, V, Se, Co, and Mo) were determined in 78 samples of raw sheep and goat milk.

In response to the growing demand for high-quality, safe, and nutritious food products, studies were conducted on the content of rare earth elements in 200 samples of Italian sheep cheeses – pecorino romano PDO and pecorino sardo PDO. It was found that a 100 g serving of both cheese types provides more than 30% of the recommended daily intake of calcium, sodium, zinc, selenium, and phosphorus, and more than 15% of the recommended daily intake of copper and magnesium. A. Mara *et al*. (2024) demonstrated that the mineral composition of both cheese types is consistent with current European standards for the biological value indicators of fermented dairy products. The human body is generally compatible with most plant-based preparations, as these compounds are frequently present in plant-derived foods. The therapeutic properties found abundantly in plants are naturally compatible with the human body.

Scientific interest in such extracts is driven by their high bioavailability, safety, and natural origin, which meet the requirements for ingredients used in functional foods, including dairy products. In this context, particular attention should be given to studying the protein and mineral composition of aqueous extracts, as this serves as the basis for further justification of their use in the production of probiotic, fermented milk, or immunostimulatory beverages. F. Abbassi *et al*. (2024) have shown that the protein composition of extracts depends on the plant species and processing conditions. Similar results were obtained for extracts of dandelion (*Taraxacum officinale*), rose hips (*Rosa canina*), plantain (*Plantago major*) and other medicinal herbs, where a protein fraction consisting of hydrophilic peptides and amino acid residues was detected. The mineral composition of extracts is also quite diverse. Studies by A. Chandran *et al*. (2024) and C. Munialo (2024) reported high concentrations of potassium, magnesium, calcium, iron, and zinc in aqueous extracts of amaranth (*Amaranthus* sp.) and fenugreek (*Trigonella foenum-graecum*). These elements not only contribute to the mineralisation of body tissues but also positively influence the enzymatic activity and immunomodulatory properties of final food products enriched with such extracts.

L. Yan & A. Kljakić (2023) reported that using a low-temperature extraction method under dark conditions allows for the preservation not only of macroelements but also of trace amounts of microelements – such as selenium, manganese, and cobalt – which play an important role in metabolism and cellular antioxidant protection. Several studies have also emphasised that aqueous extracts derived from non-toxic plants can be used as additives in fermented dairy products to enrich their amino acid profile and mineral composition (Damani & Topi, 2022; Yarmolinsky *et al*., 2024). Considering that information on the nutritional value of aqueous plant extracts is limited, conducting such a study is both scientifically and practically justified. The results obtained may not only expand the understanding of the nutritional potential of these plant-based substances but also serve as a foundation for the further development of new food products with enhanced biological value.

The aim of this study was to examine the protein and mineral composition of several types of aqueous plant extracts as potential sources of minerals and proteins. To achieve this aim, the following objectives were set: to prepare aqueous extracts of selected medicinal plants using the method developed by Academician V. Filatov; to examine their protein and mineral composition and draw conclusions regarding their potential for use in the production of functional dairy products; and, based on the results of the mineral composition analysis, to outline directions for further scientific research.

Materials and Methods

The study was conducted from May to August 2025 in the laboratory of Smartbiolab LLC and the Institute of Food Resources of the National Academy of Agrarian Sciences of Ukraine. Extracts were prepared from the following plants: Elamin (kelp) *Laminaria*; liquorice root (*Glycyrrhiza glabra*); young cherry leaves (*Prunus cerasus*); young cherry branches; dill leaves (*Anethum graveolens*); dill seeds; rosemary leaves (*Rosmarinus officinalis*); chamomile flowers (*Matricaria chamomilla*); angelica root (*Angelica archangelica*); beggarticks leaves (*Bidens tripartita*); fireweed leaves (*Chamaenerion angustifolium*); stevia leaves (*Stevia rebaudiana*). The plant raw materials were collected and purchased at the Experimental Station of Medicinal Plants of the Institute of Agroecology and Environmental Management of the National Academy of Agrarian Sciences of Ukraine. The choice of plant raw materials was governed by their prevalence in Ukraine and their high content of biologically active compounds of various types, in particular polyphenols, essential oils, organic acids and minerals. The selected plants are readily available domestic resources and are characterised by antioxidant, antimicrobial and functional properties, making their use in food technologies appropriate. This allows for the justification of developing products from local plant raw materials. The plant extracts were prepared according to the method developed by Academician V. Filatov, who studied the effects of biogenic stimulators such as aloe on the body's defences and their role in regeneration and recovery processes (Kovalyov *et al.*, 2014). Individual 50 g portions of plant material were covered with water to a total volume of 1 litre and infused for 7-8 days. The mixture was stirred six times during infusion, then heated in a water bath for 5-7 minutes. The aqueous mixture of herbs was filtered to separate the liquid and solid fractions. The filtrates were dispensed into 100 mL bottles and sterilised at 120°C for 15 minutes.

The plant materials were rinsed under running tap water. Leafy plant materials were air-dried and ground in a coffee grinder, whilst root materials were soaked in water for 24 hours before grinding, and their outer skins were removed prior to processing. Samples were prepared by weighing 25 g of plant material and adding distilled water up to the 1 dm^3 mark (925 mL). The mixtures were stirred in containers and left to stand undisturbed in a cool, dark place. Extraction of active compounds from the studied plant ingredients was carried out at a temperature of (12 ± 2)°C for 3-4 days. Upon completion of the extraction process, the solid plant material was separated from the liquid by filtration. The liquid portion was sterilised in an autoclave at (120 ± 2)°C for 15 minutes, cooled to (20 ± 2)°C, and then subjected to physicochemical analysis using a Biochemical Analyser RT-1904C (Rayto Electronics, China) in the laboratory of Smartbiolab LLC. The wavelength parameters used during the analyses were as follows: albumin – 620 nm; protein – 546 nm; potassium – 578 nm; calcium – 670 nm; magnesium – 546 nm; phosphorus (UV) – 340 nm; zinc – 546 nm. Statistical analysis of the data was performed using Microsoft Excel 2016. Each experiment was performed in triplicate (n = 3). Results were considered statistically reliable at a significance level of $p \leqslant 0.05$.

Results and Discussion

The selected raw material covers a wide range of biologically active components of various nature, which allows for a comprehensive assessment of the physicochemical and functional characteristics of aqueous plant extracts. The evaluation of the protein and mineral composition of 12 samples of aqueous plant extracts revealed significant variability of parameters depending on the type of raw material. The physicochemical parameters of the plant extracts, expressed in grams per litre, are presented in Table 1.

Table 1. *Physicochemical indicators of plant extracts*

Extract name	Protein, g/L	Albumin, g/L	Calcium (Ca), mg/L	Phosphorus (P), mg/L	Magnesium (Mg), mg/L	Potassium (K), mg/L	Zinc (Zn), mg/L
Elamin	5.98	0.08	3.65	2.45	3.72	22.03	4.46
Liquorice root	3.73	0.50	2.82	0.64	3.51	4.19	1.62
Young cherry leaves	4.66	–	2.67	1.27	2.54	5.72	7.90
Dill leaves	5.04	0.15	4.48	2.73	3.43	6.82	8.92
Rosemary leaves	17.54	0.34	4.94	5.12	3.57	9.46	47.82
Chamomile flowers	3.17	0.57	3.62	7.17	3.73	3.94	11.15
Dill seeds	2.99	0.04	4.03	2.78	3.98	7.10	0.20
Young cherry branches	1.31	0.27	2.65	0.25	2.38	2.26	3.45
Angelica root	1.68	0.34	2.49	6.45	3.37	10.66	7.90
Beggarticks leaves	13.06	0.08	4.41	5.07	4.00	11.36	36.88
Fireweed leaves	8.77	0.31	3.80	4.46	2.54	5.46	35.67
Stevia leaves	13.06	0.42	3.89	7.37	4.13	6.62	38.50
Tap water	–	–	1.81	–	1.03	0.08	1.62

Source: compiled by the authors

From the data in Table 1 it is clear that the revealed trend of growth of the content of total plant protein in aqueous extracts depending on the type of plant raw materials indicates a significant influence of anatomical and morphological features of plants on the efficiency of extraction of protein components. The lowest values are characteristic of woody tissues and root raw materials, while a significantly higher protein content is inherent in leaves and generative organs, which is due to a more intensive metabolism and a higher concentration of water-soluble compounds. The maximum indicators were recorded in leaf raw materials, in particular in stevia, beggarticks and rosemary, which confirms its prospects as a source of plant protein for the creation of functional food products. The results obtained also indicate the feasibility of targeted selection of plant raw materials of leaf nature to increase the protein value of extracts and optimise the recipes of functional and fermented products. The highest protein concentration was found in: rosemary leaves (17.54 g/L), fireweed leaves (8.77 g/L), and stevia and beggarticks leaves (13.06 g/L each). The lowest protein concentration was observed in cherry branches (1.31 g/L), angelica roots (1.68 g/L), and dill seeds (2.99 g/L). This may be due to lower extractability or a low content of protein compounds in the raw plant material.

According to G. Nieto *et al*. (2018), rosemary leaves contain significant amounts of proteins, flavonoids, and phenolic acids, which determine their high biological activity. Stevia is also known for its high content of protein compounds and amino acids (Žlabur *et al*., 2013; Ahmad *et al*., 2020). Albumin content (g/L): was absent in young cherry leaves. In ascending order, it was detected in dill seeds (0.04); elamin and beggarticks leaves (both 0.08); dill leaves (0.15); young cherry branches (0.27); fireweed leaves (0.31); rosemary leaves and angelica root (both 0.34); stevia leaves (0.42); liquorice root (0.50); chamomile flowers (0.57). Although albumin represents a small fraction of the total protein, its presence is important due to its high biological value. The highest albumin content was recorded in: chamomile flowers – 0.57 g/L, liquorice root – 0.50 g/L, stevia leaves – 0.42 g/L. At the same time, the albumin fraction was not detected in the leaves of young cherry, indicating a different structure of protein compounds. Thus, it can be concluded that most of the extracts can be used as raw materials for obtaining plant protein and albumin, which was absent in young cherry leaves.

According to the data in Table 1, a clear increasing trend in calcium (Ca) content in aqueous extracts is observed depending on the type of plant raw material. The lowest levels are characteristic of root and woody materials, while higher calcium concentrations are typical of leaves and seeds. This pattern can be explained by the physiological role of calcium in actively metabolising tissues, particularly in leaves, where it participates in cellular structure formation and metabolic regulation. The highest calcium content is observed in leaf-based raw materials, especially rosemary, dill, and beggarticks, indicating their potential as promising sources of mineral enrichment for functional food formulations. The lowest calcium content was found in the extract of angelica root (2.49 mg/L) and cherry branches (2.65 mg/L), while the highest level, among the edible raw materials used as the basis for extract preparation, was observed in dill leaves (4.48 mg/L); and among the wild plant extracts – in rosemary leaves (4.94 mg/L). Similar values were reported by R. Subramanian *et al*. (2012) and Radha *et al*. (2021), who investigated the calcium profile of aqueous extracts of medicinal plants, including dill (Anethum graveolens), with up to 4.2 mg/L Ca in hot infusions.

A similar trend is observed for phosphorus (P) content in aqueous extracts, which varies depending on the type of plant raw material. Lower phosphorus levels are characteristic of woody tissues and certain root materials, whereas a gradual increase is noted in leaves, seeds, and flowers. This distribution is determined by the biological role of phosphorus in energy metabolism and the synthesis of cellular components, which occur more intensively in metabolically active plant organs. The highest phosphorus content is found in leaf and flower materials, particularly in stevia, chamomile, and rosemary. Thus, particularly high values were found in chamomile flowers (7.17 mg/L) and stevia leaves (7.37 mg/L), while the lowest levels were observed in cherry branches (0.25 mg/L) and liquorice roots (0.64 mg/L). However, these concentrations are sufficiently high for effective use, for instance, in the fortification of dairy products intended for special diabetic nutrition. The same conclusion applies to the analysis of the mineral composition of other plant-based extracts. These results are also consistent with the findings of A. El Mihyaoui *et al*. (2022) and M. Saeedi *et al*. (2024), which reported that medicinal chamomile is rich in phosphorus.

A consistent increasing trend in magnesium (Mg) content in aqueous extracts is observed depending on the type of plant raw material. The lowest levels are typical of woody tissues and some leaf materials with lower metabolic activity, while higher concentrations are characteristic of leaves, seeds, and flowers. This pattern is associated with the key role of magnesium in photosynthesis and enzymatic processes, leading to its accumulation in metabolically active plant organs. The highest magnesium content is observed in leaf-based raw materials, particularly stevia and beggarticks. Thus, the lowest magnesium content was found in extracts from young cherry leaves and fireweed leaves (2.54 mg/L each), while the highest levels were recorded in extracts from beggarticks leaves (4.00 mg/L) and stevia leaves (4.13 mg/L), respectively. The lowest potassium (K) content, in increasing order, was found in the following aqueous extracts (mg/L): young cherry branches (2.26), chamomile flowers (3.94), liquorice roots (4.19), fireweed leaves (5.46), young cherry leaves (5.72), stevia leaves (6.62), dill leaves (6.82), dill seeds (7.10), rosemary leaves (9.46), angelica roots (10.66), beggarticks leaves (11.36), and elamin (22.03). A significant accumulation of potassium was observed in elamin (22.03 mg/L), which substantially exceeded all other samples, while the lowest potassium level was found in cherry branch extracts – 2.26 mg/L.

A pronounced increasing trend in zinc (Zn) content in aqueous extracts is observed depending on the type of plant raw material. The lowest levels are characteristic of seeds and root materials, while a substantial increase is noted in leaves and flowers. This pattern is determined by the biological role of zinc as an essential trace element involved in enzymatic activity and metabolic regulation, leading to its higher accumulation in metabolically active plant tissues. The highest zinc content is found in leaf-based raw materials, particularly rosemary, stevia, and beggarticks. A high Zn content was characteristic of rosemary (47.82 mg/L), beggarticks (36.88 mg/L), and stevia leaves (38.50 mg/L), while the lowest concentration was recorded in dill seeds – only 0.20 mg/L.

According to J. Suliburska & K. Kaszmarek (2012) and P. Konieczynski & M. Wesolowski (2015), the zinc content in rosemary extracts ranges from 20 to 35 mg/L. Stevia and beggarticks also exhibit a high zinc content (36.88-38.5 mg/L), consistent with the findings of A. Plaskova & J. Mlcek (2023), who emphasised the mineralising potential of plants in this group. An analysis was also conducted on the water used for extract preparation. Phosphorus was not detected in the water sample. The concentrations of four mineral elements – calcium (Ca), magnesium (Mg), potassium (K), and zinc (Zn) – were 1.81, 1.03, 0.08, and 1.62 mg/L, respectively. These findings are consistent with the conclusions of A. Tytarenko & E. Hryshyna (2011), who stated that water supplies only about 1.0-10% of the body's mineral requirements. For all parameters (with few exceptions), the extracts significantly exceeded the levels found in tap water, indicating the high extractive capacity of medicinal plant materials and their potential for nutritional enrichment. Studies by L. Oraon *et al.* (2017), S. El-Sayed & A. Youssef (2019), and A. Kandyliari *et al.* (2023) have confirmed that aqueous plant extracts can serve as an effective means of enhancing the nutritional and functional value of food products. Thus, the most nutritious extracts in terms of total protein and mineral content are those derived from rosemary, stevia, beggarticks, and fireweed. The extract from elamin showed the highest potassium content, while rosemary had the highest zinc concentration. A significant variability was observed among extracts of different botanical origins, allowing for targeted selection of raw materials depending on the desired nutrient enrichment profile of food products.

Conclusions

A comprehensive study of the physicochemical composition of 12 types of aqueous plant extracts prepared according to the method of Academician V. Filatov was conducted. The results expand understanding of the protein and mineral content present in the analysed aqueous plant extracts. It was found that extracts from rosemary, stevia, beggarticks, and fireweed leaves contain the highest levels of total protein (8.77-17.54 g/L), indicating their potential as sources of protein components in food technologies. The data obtained allow for preliminary calculations to determine the optimal dosage of these extracts for enriching dairy products, taking into account the existing daily requirements of the human body for protein and minerals. Among the studied samples, the highest content of mineral elements (calcium, phosphorus, magnesium, potassium, and zinc) was recorded in extracts of rosemary, stevia, and beggarticks, which may enhance their biological value when incorporated into functional foods. Extracts from chamomile flowers, angelica root, and fireweed leaves demonstrated a high content of trace elements, particularly zinc (up to 47.82 mg/L), making them suitable for use as natural mineralising agents in dietary and infant nutrition. The established variability in the composition of the extracts makes it possible to purposefully select plant components according to the functional purpose of the food product. It is expected that dairy products enriched with essential plant extractives obtained from natural plant materials can be classified as functional foods. Further research should be aimed at studying the technological compatibility of plant extracts with dairy raw materials, their stability during storage, and the organoleptic evaluation of the final products.

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Conflict of Interest

None.

References

[1] Abbassi, F., Hamdi, A., Tlahig, S., Triki, T., Nagaz, K., & Guasmi, F. (2024). Phytochemical analysis and biological activities of *Reamuria vermiculata* leaves, stem and roots extracts. *Polish Journal of Environmental Studies*, 33(1), 31-41. doi: 10.15244/pjoes/169896.

[2] Ahmad, J., Khan, I., Blundell, R., Azzopardi, J., & Mahomoodally, M.F. (2020). *Stevia rebaudiana* Bertoni.: An updated review of its health benefits, industrial applications and safety. *Trends in Food Science & Technology*, 100, 177-189. doi: 10.1016/j.tifs.2020.04.030.

[3] Chandran, A.S., Kashyap, P., & Thakur, M. (2024) Effect of extraction methods on functional properties of plant proteins: A review. *eFood*, 5(3), article number e151. doi: 10.1002/efd2.151.

[4] Damani, Z., & Topi, D. (2022). Application of plant extracts in the food and pharmaceutical industry. *Novel Techniques in Nutrition & Food Science*, 6(4), 590-593. doi: 10.31031/NTNF.2022.06.000644.

[5] El Mihyaoui, A., Esteves da Silva, J.C.G., Charfi, S., Candela Castillo, M.E., Lamarti, A., & Arnao, M.B. (2022). Chamomile (*Matricaria chamomilla* L.): A review of ethnomedicinal use, phytochemistry and pharmacological uses. *Life*, 12(4), article number 479. doi: 10.3390/life12040479.

[6] El-Sayed, S.M., & Youssef, A.M. (2019). Potential application of herbs and spices and their effects in functional dairy products. *Heliyon*, 5(6), article number e01989. doi: 10.1016/j.heliyon.2019.e01989.

[7] Jin, D., Wei, X., He, Y., Zhong, L., Lu, H., Lan, J., Wei, Y., Liu, Z., & Liu, H. (2024). The nutritional roles of zinc for immune system and COVID-19 patients. *Frontiers in Nutrition*, 11, article number 1385591. doi: 10.3389/fnut.2024.1385591.

[8] Kandyliari, A., *et al*. (2023). Development of dairy products fortified with plant extracts: Antioxidant and phenolic content characterization. *Antioxidants*, 12(2), article number 500. doi: 10.3390/antiox12020500.

[9] Konieczynski, P., & Wesolowski, M. (2015). Phosphorus, iron, manganese, zinc and copper in relation to total flavonoids in medicinal herbs and their infusions originating from Poland, Lithuania and Ukraine. *Enviromental Protection and Natural Resources*, 26(4), 26-29. doi: 10.1515/oszn-2015-0024.

[10] Kovalyov, V.M., *et al*. (2014). *Workshop on the identification of medicinal plant raw materials*. Ternopil: Ternopil State Medical University.

[11] Mara, A., Caredda, M., Addis, M., Sanna, F., Deroma, M., Georgiou, C.A., Langasco, I., Pilo, M.I., Spano, N., & Sanna, G. (2024). Elemental fingerprinting of pecorino romano and pecorino sardo PDO: Characterization, authentication and nutritional value. *Molecules*, 29(4), article number 869. doi: 10.3390/molecules29040869.

[12] Matasar, I.T., Petryshchenko, L.M., & Matasar, T.V. (2021). Macroelements and their role in the human body in living conditions in areas contaminated by the Chernobyl accident. *One Health and Nutrition Problems of Ukraine*, 55(2), 56-82. doi: 10.33273/2663-9726-2021-55-2-56-82.

[13] Munialo, C.D. (2024). A review of alternative plant protein sources, their extraction, functional characterisation, application, nutritional value and pinch points to being the solution to sustainable food production. *International Journal of Food Science and Technology*, 59(1), 462-472. doi: 10.1111/ijfs.16467.

[14] Nieto, G., Ros, G., & Castillo, J. (2018). Antioxidant and antimicrobial properties of rosemary (*Rosmarinus officinalis*, L.): A review. *Medicines*, 5(3), article number 98. doi: 10.3390/medicines5030098.

[15] Oraon, L., Atanu, J., Prajapati, P.S., & Savata, P. (2017). Application of herbs in functional dairy products – a review. *Journal of Dairy Veterinary & Animal Research*, 5(3), 109-115. doi: 10.15406/jdvar.2017.05.00145.

[16] Plaskova, A., & Mlcek, J. (2023). New insights of the application of water or ethanol-water plant extract rich in active compounds in food. *Frontiers in Nutrition*, 10, article number 1118761. doi: 10.3389/fnut.2023.1118761.

[17] Radha, *et al*. (2021). Evaluation of nutritional, phytochemical, and mineral composition of selected medicinal plants for therapeutic uses from cold desert of Western Himalaya. *Plants*, 10(7), article number 1429. doi: 10.3390/plants10071429.

[18] Saeedi, M., Khanavi, M., Shahsavari, K., & Manayi, A. (2024). *Matricaria chamomilla*: An updated review on biological activities of the plant and constituents. *Research Journal of Pharmacognosy*, 11(1), 109-136. doi: 10.22127/RJP.2023.404256.2145.

[19] Savarino, G., Corsello, A., & Corsello, G. (2021). Macronutrient balance and micronutrient amounts through growth and development. *Italian Journal of Pediatrics*, 47, article number 109. doi: 10.1186/s13052-021-01061-0.

[20] Subramanian, R., Gayathri, S., Rathnavel, C., & Raj, V. (2012). Analysis of mineral and heavy metals in some medicinal plants collected from local market. *Asian Pacific Journal of Tropical Biomedicine*, 2(1), 74-78. doi: 10.1016/S2221-1691(12)60133-6.

[21] Suliburska, J., & Kaszmarek, K. (2012). Herbal infusions as a source of calcium, magnesium, iron, zinc and copper in human nutrition. *International Journal of Food Sciences and Nutrition*, 63(2), 194-198. doi: 10.3109/09637486.2011.617359.

[22] Tedesco, R., Hidalgo, M.C.V., Vardè, M., Kehrwald, N.M., Barbante, C., & Cozzi, G. (2021). Trace and rare earth elements determination in milk whey from the Veneto region, Italy. *Food Control*, 121, article number 107595. doi: 10.1016/j.foodcont.2020.107595.
[23] Tytarenko, A.V., & Hryshyna, E.O. (2011). The effect of vitamins and minerals on the human body. *Scientific Notes of KNTU*, 11(3), 240-246.
[24] Yan, L., & Kljakić, A.C. (2023). The extraction, characterization and biological activity of natural products. *Plants*, 12(19), article number 3382. doi: 10.3390/plants12193382.
[25] Yarmolinsky, L., Nakonechny, F., Haddis, T., Khalfin, B., Dahan, A., & Ben-Shabat, S. (2024). Natural antimicrobial compounds as promising preservatives: A look at an old problem from new perspectives. *Molecules*, 29(24), article number 5830. doi: 10.3390/molecules29245830.
[26] *Žlabur*, Š.J., Voća, S., Dobričević, N., Ježek, D., Bosiljkov, T., & Brnčić, M. (2013). *Stevia rebaudiana* Bertoni – a review of nutritional and biochemical properties of natural sweetener. *Agriculturae Conspectus Scientificus*, 78(1), 25-30.

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Анотація. Незважаючи на широку доступність сировини, наукові дані щодо фізико-хімічних властивостей водних екстрактів багатьох перспективних рослин залишаються обмеженими. Більшість досліджень зосереджені на спиртових або комбінованих екстрактах, тоді як водні екстракти часто розглядаються лише в контексті традиційної медицини. Мета цього дослідження полягала у визначенні білкового та мінерального складу водних екстрактів обраних лікарських рослин та оцінці їх потенціалу як джерел функціональних інгредієнтів для харчової промисловості. Водні екстракти були приготовлені з 12 видів рослинної сировини, включаючи *Laminaria* (Elamin), листя та гілки вишні, корінь солодки, листя розмарину, кріп (листя та насіння), ромашку, корінь дягелю, календулу, іван-чай та стевію, за методом, розробленим В. Філатовим. Фізико-хімічний аналіз включав визначення загального білка, альбуміну, кальцію, фосфору, магнію, калію та цинку за допомогою біохімічного аналізатора. Результати показали значну варіабельність вмісту білка (1,31-17,54 г/л) та мінералів залежно від ботанічного походження сировини. Найвищі концентрації білка виявлено в екстрактах із листя розмарину, стевії, календули та іван-чаю. Екстракт ламінарії мав найвищий вміст калію, тоді як екстракт розмарину – найвищий вміст цинку. Екстракти ромашки, дягелю та іван-чаю також продемонстрували високий рівень життєво важливих мікроелементів, особливо фосфору та цинку. Усі зразки показали значно вищі концентрації біоактивних сполук порівняно з питною водою, що підтверджує ефективність методу екстракції. Отримані дані підтримують можливість використання таких екстрактів для збагачення функціональних молочних продуктів

Ключові слова: вміст білка; мінеральний склад; функціональні інгредієнти; функціональні молочні продукти; рослинне збагачення