

## Determination of The Content of Macro- and Microelements in Common Raspberry Leaves (*Rubus Idaeus L.*)

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### Abstract

*For the first time in Uzbekistan, the content of macro- and microelements in common raspberry (*Rubus idaeus L.*) leaves was determined using modern analytical methods. The obtained results demonstrated the importance of these findings in assessing the pharmaceutical significance of the plant. According to the results, a number of macro- and microelements, including potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), zinc (Zn), and copper (Cu), were identified in the plant leaves. These elements are essential for physiological processes in the human body.*

**Keywords:** *Rubus idaeus L.*, elemental composition, macroelements, microelements, ICP-MS.

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### 1. Introduction

In addition to biologically active substances, mineral elements contained in medicinal plants are of great importance for human health. In recent years, the study of macro- and microelements in medicinal plants has become an important area of scientific research. This is of great significance for the standardization of medicinal plants and the quality control of medicinal plant materials.

Macro- and microelements are minerals essential for the normal growth, development, and vital functions of the human body. They participate in metabolic processes and are involved in the composition and functioning of enzymes, vitamins, and hormones. Mineral substances, namely macro- and microelements, serve as catalysts for biochemical reactions in the human body and as building materials for the skeleton.

Although elements have no nutritional value in themselves, they are essential substances involved in maintaining osmotic pressure and ensuring a constant pH level of the body's intracellular and extracellular fluids. In addition, it can be stated that the participation of essential microelements is also significant in the formation of protective responses against stress, infections, and colds.

Recently, considerable attention has been paid to studying the microelement composition of medicinal plants, and this work has two important aspects. First, the elemental composition of a medicinal plant growing in a particular region, as well as extracts, medicinal preparations, and medicinal raw materials obtained from it, can characterize their purity and be considered a specific reflection of the biogeochemical and ecological conditions of a particular region. Second, the effects of the main biologically active

substances contained in herbal preparations are often associated with the natural.

The effects of macro- and microelements that determine the mineral composition may manifest themselves in combination with one another [1].

**The aim of this study.** Common raspberry (*Rubus idaeus* L.) growing in the Republic of Uzbekistan is widely used in folk medicine. Since its leaves possess anti-inflammatory, antioxidant, and general restorative properties, the aim of this study was to determine the content of macro- and microelements in its leaves.

## 2. Methods

The research object consisted of common raspberry (*Rubus idaeus* L.) leaves grown in the Tashkent region of the Republic of Uzbekistan. The elemental composition of the leaves, which were dried in a cool, dry place, was analyzed using the ICP-MS method [1]. An accurately weighed sample of 0.1 g (100 mg) was quantitatively transferred into Teflon autoclaves. Then, 3 mL of purified and concentrated nitric acid ( $\text{HNO}_3$ ) and 2 mL of purified hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) were added. The autoclaves were sealed and placed

in a Berghof microwave digestion system (Speed Wave Xpert or an equivalent device). The temperature and pressure inside the autoclaves were automatically controlled and monitored by the instrument. Process data were displayed on a liquid-crystal display.

Wet digestion was carried out for 35–45 minutes under conditions with a minimum temperature of  $50^\circ\text{C}$ , a maximum temperature of  $230^\circ\text{C}$ , and a maximum pressure of 40 bar. The autoclaves were then cooled to room temperature, and the liquid mixture inside was quantitatively transferred into a 50- or 100-mL volumetric flask. The autoclaves were rinsed 2–3 times, and the rinsing solution was added to the flask. The volume was then brought to the mark with purified water. The solution was thoroughly mixed, transferred into a test tube, and placed in the autosampler.

The mineralized solution was analyzed using an inductively coupled plasma mass spectrometer (ICP-MS, NexION 2000) manufactured by PerkinElmer. During the analysis, the sample mass and dilution values were entered. The instrument automatically calculated the relative standard deviation (RSD) values [2,3].

### SCHEMATIC DIAGRAM FOR THE DETERMINATION OF MACRO-, MICROELEMENTS AND HEAVY METALS IN PLANT SAMPLES USING MICROWAVE DIGESTION AND ICP-MS

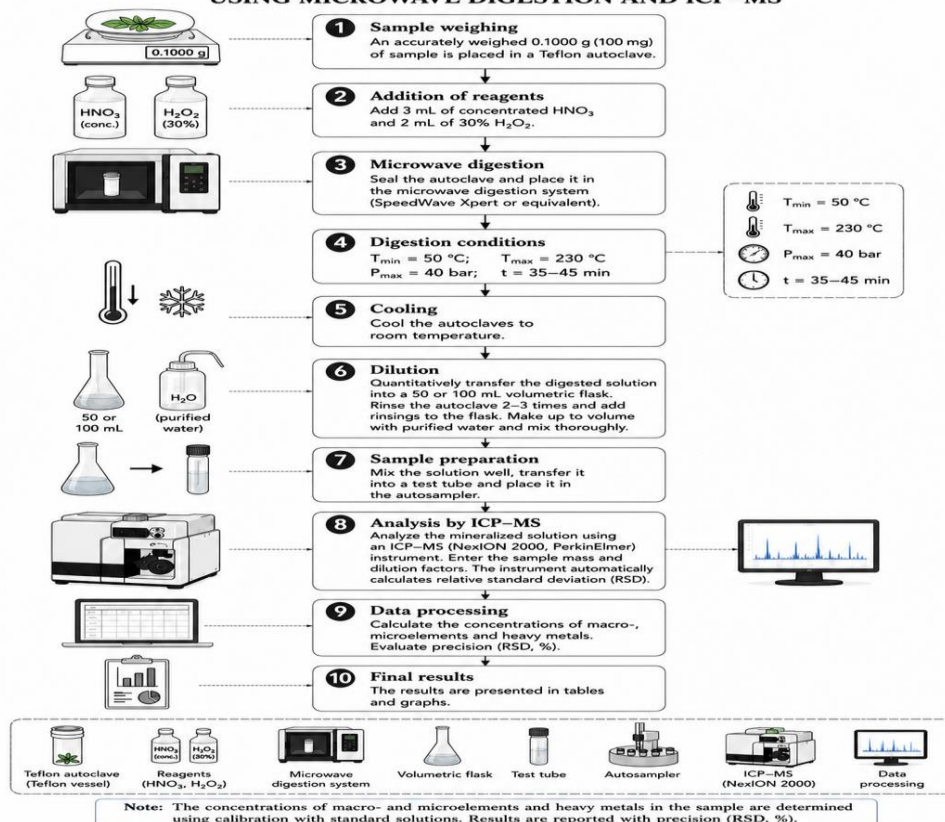


Figure 1. General flowchart of plant sample preparation and analysis by ICP–MS

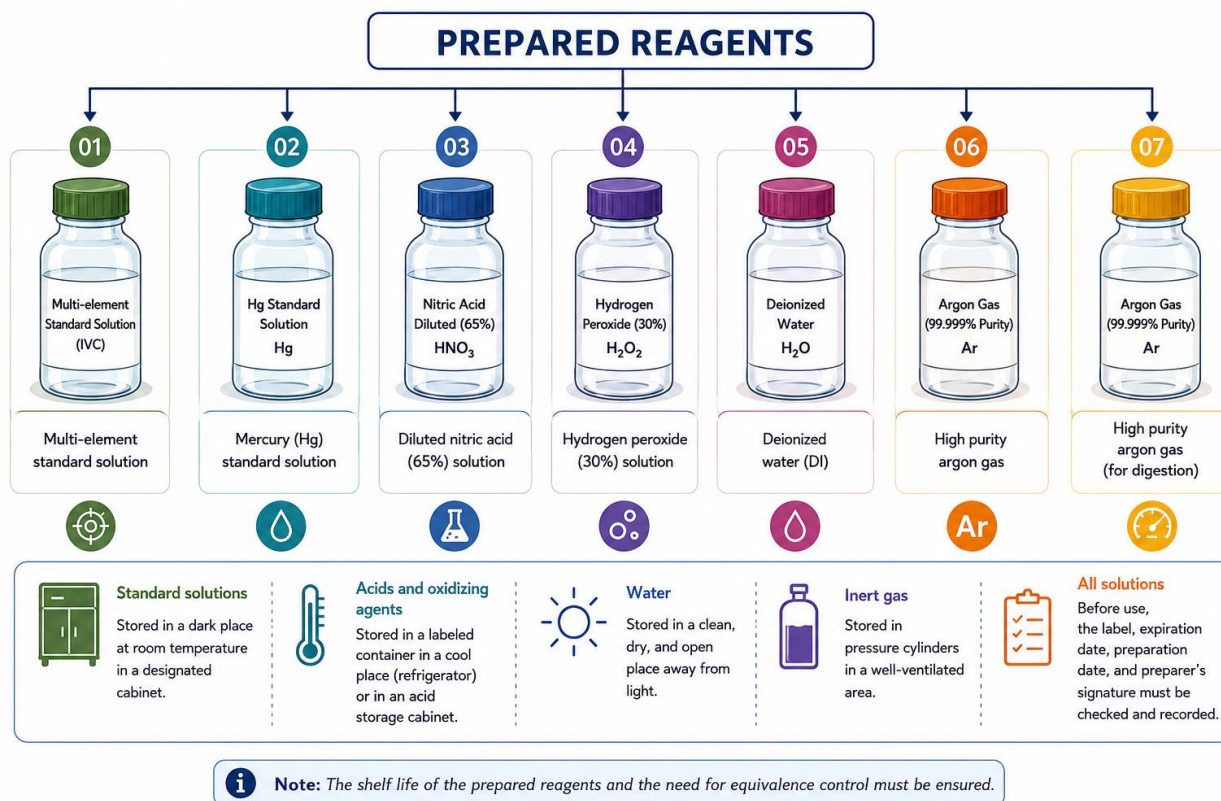


Figure 2. Reagents used for the analysis of plant samples by ICP–MS

### 3. Results and Discussion

According to the analysis results, the leaves of the red

raspberry (*Rubus idaeus* L.) were found to contain 40 mineral elements (Table 1).

Table 1. List of elements identified in the plant sample (n = 40)

|                                |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |
|--------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Macro-elements                 | 1<br><b>K</b>   | 2<br><b>Ca</b>  | 3<br><b>Mg</b>  | 4<br><b>P</b>   | 5<br><b>S</b>   |                 |                 |                 |                 |                 |
|                                | 6<br><b>Fe</b>  | 7<br><b>Si</b>  | 8<br><b>Na</b>  | 9<br><b>Al</b>  | 10<br><b>B</b>  |                 |                 |                 |                 |                 |
| Micro-elements                 | 11<br><b>Mn</b> | 12<br><b>Ba</b> | 13<br><b>Sr</b> | 14<br><b>Zn</b> | 15<br><b>Ti</b> | 16<br><b>Cu</b> | 17<br><b>Cr</b> | 18<br><b>Ni</b> | 19<br><b>Mo</b> | 20<br><b>Ga</b> |
|                                | 21<br><b>Rb</b> | 22<br><b>Li</b> | 23<br><b>Sn</b> | 24<br><b>Hg</b> | 25<br><b>V</b>  | 26<br><b>Zr</b> | 27<br><b>Be</b> | 28<br><b>Co</b> | 29<br><b>As</b> | 30<br><b>Ag</b> |
| Rare earth elements and others | 31<br><b>Se</b> | 32<br><b>Sb</b> | 33<br><b>Cd</b> | 34<br><b>Nb</b> | 35<br><b>Cs</b> | 36<br><b>Ge</b> | 37<br><b>W</b>  | 38<br><b>In</b> | 39<br><b>Ta</b> | 40<br><b>Re</b> |

Macro-elements:  
essential elements required  
in large amounts by plants.

Micro-elements:  
essential elements required  
by plants in small amounts.

Other elements:  
various elements that  
may be present in plants  
in certain amounts.

Rare earth elements  
and others:  
rare earth and other  
elements.

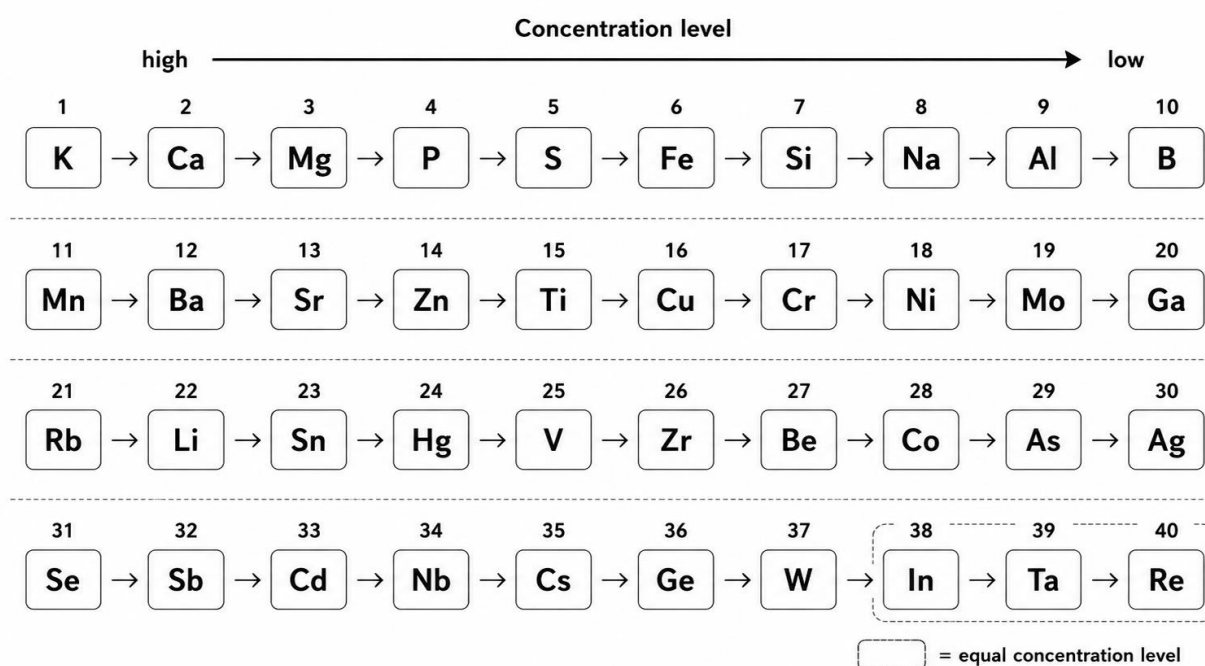
Source: Elements identified were analyzed by Inductively Coupled Plasma Mass Spectrometry (ICP–MS).

Of these, 8 elements (Na, Mg, Si, P, S, K, Ca, and Fe) were present in concentrations ranging from 100 to 1000 mg/kg; 1 element (Al) ranged from 10 to 100 mg/kg; 6 elements (B, Ba, Mn, Sr, Ti, and Zn) ranged from 1 to 10 mg/kg; and 25 elements (Li, Be, Rb, Cr, Co, Ni, Ga, Ge, As, Se, V, Zr, Sn, Cu, Nb, Mo, Ag, Cd, In, Sb, Cs, Ta, W, Re, and Hg) were present at concentrations below 1 mg/kg.). The obtained data indicate that the leaves of *Rubus idaeus* L. contain 40 elements. Among these elements, calcium, magnesium, potassium, and sodium, which enter cells in the form of ions, are of vital importance. Some of the identified

elements belong to the group of macronutrients (Na, K, Ca, P, Mg, and S). Sodium, magnesium, silicon, phosphorus, sulfur, potassium, calcium, and iron were detected in the highest concentrations. The identified elements can be arranged in descending order of their concentrations as follows:

$K > Ca > Mg > P > S > Fe > Si > Na > Al > B > Mn > Ba > Sr > Zn > Ti > Cu > Cr > Ni > Mo > Ga > Rb > Li > Sn > Hg > V > Zr > Be > Co > As > Ag > Se > Sb > Cd > Nb > Cs > Ge > W > In = Ta = Re$

**Figure 1. Decreasing order of element concentrations in the plant sample**



**Note:** The elements are arranged in decreasing order of their concentrations.

"→" indicates that the concentration of the element on the left is higher than that of the element on the right.

"=" indicates that the concentrations of the elements are equal.

The leaves of common raspberry (*Rubus idaeus* L.) were found to contain 16 macroelements among the 40 identified elements. Macroelements constitute the main group of mineral substances essential for the human body and perform important biological functions in metabolic processes, enzymatic reactions, and maintaining the structural integrity of tissues. These elements are required by the human body in relatively large amounts, and their deficiency or excessive accumulation may contribute to the development of various physiological and pathological conditions [4]. In the present study, potassium (K), calcium (Ca), magnesium (Mg), phosphorus (P), sulfur (S), iron (Fe), silicon (Si), sodium (Na), and aluminum (Al) and boron (B) were identified, among which the  $K > Ca > Mg > P > S$  sequence showed the highest predominance. The

following benefits of these elements for the human body can be observed [2].

Potassium is the main intracellular cation and plays an important role in maintaining osmotic pressure, regulating water-electrolyte balance, transmitting nerve impulses, and facilitating muscle contraction, particularly that of the cardiac muscle. In addition, it is involved in carbohydrate and protein metabolism and regulates the activity of numerous enzymes. Adequate potassium intake may help reduce the risk of arterial hypertension and cardiovascular diseases.

Calcium is the most abundant mineral element in the human body, with approximately 99% located in bone and tooth

tissues. It is essential for bone mineralization, blood coagulation, transmission of nerve impulses, muscle contraction, and cellular signaling. Calcium deficiency may lead to the development of osteopenia, osteoporosis, and muscle spasms [5,6].

Magnesium is a cofactor for more than 300 enzyme systems. It is involved in ATP metabolism, protein and nucleic acid synthesis, neuromuscular function, and maintenance of normal heart rhythm. Magnesium is also an important component of the antioxidant defense system and contributes to reducing oxidative stress.

Phosphorus is a central element in energy metabolism and is a component of ATP, nucleic acids, and phospholipids. In addition, it performs important biological functions in the structure of cell membranes, acid-base balance, and mineralization of bone tissue.

Sulfur is a structural component of amino acids such as cysteine and methionine, as well as glutathione and certain coenzymes. This element is actively involved in protein synthesis, detoxification processes, and antioxidant defense. Sulfur is also essential for the normal development of connective tissue, skin, hair, and nails.

Iron is a major component of hemoglobin and myoglobin and plays a crucial role in oxygen transport and cellular respiration. In addition, it serves as a cofactor for many oxidation-reduction enzymes. Iron deficiency is one of the main causes of iron-deficiency anemia.

Sodium is the principal extracellular cation and regulates water-salt balance, osmotic pressure, and the transmission of nerve impulses. At the same time, excessive sodium intake may increase blood pressure and the risk of developing cardiovascular diseases [7].

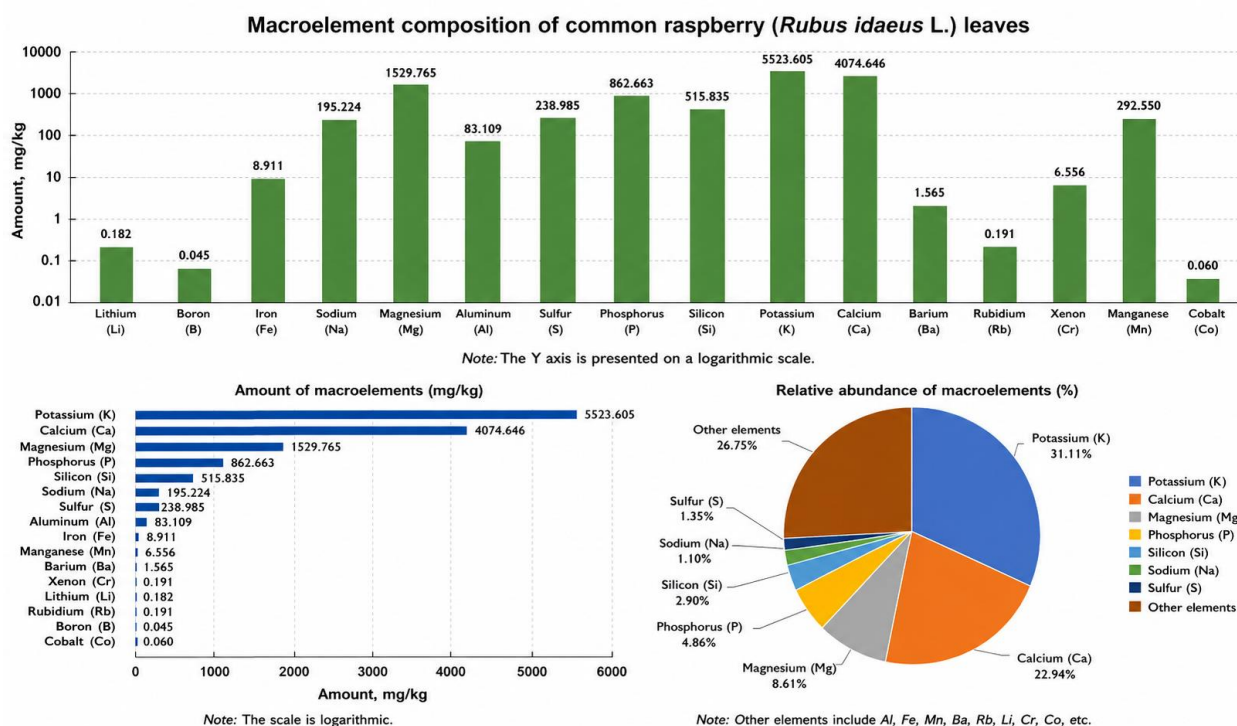
Deficiency of these elements can lead to various diseases (anemia, rickets, goiter, etc.) and disturbances in vital physiological processes. Potassium (K) and Sodium (Na) maintain water-salt balance, transmit nerve impulses, and regulate cardiac function. Potassium plays a very important

role in the human body. This chemical element is essential not only for the normal functioning of the excretory, musculoskeletal, cardiovascular, and nervous systems, but also for various other physiological processes in the body. Although potassium is efficiently absorbed when consumed with food, it is rapidly excreted from the body. Therefore, it is important to maintain an adequate balance of this element and prevent its deficiency [8]. Potassium is responsible for neuromuscular excitability and muscle contraction in response to stimuli and helps maintain the electrical activity of the brain.

Sodium belongs to the group of macronutrients that perform important functions in the human body. Its primary role is to maintain an optimal water-salt balance in the body. However, sodium can provide greater benefits to the body when functioning in combination with other elements. The benefits of sodium for the human body are evident—it

maintains a healthy state and ensures normal growth. In combination with chlorine, sodium can prevent the movement of fluid from the capillaries and blood vessels into the surrounding tissues. Sodium is involved in the transport of various substances throughout the body. Thus, it transports sugars through cells, transmits nerve signals and impulses, and participates in muscle contraction. Adequate sodium levels in the body help prevent heat exhaustion and sunstroke. Sodium also ensures proper brain function and contributes to normal cognitive activity. Reducing daily sodium intake may cause episodes of dizziness and, in rare cases, lethargy. In addition, reduced sodium intake may lead to mental confusion [9].

Magnesium deficiency can cause anxiety, fear, confusion, and depression. Hyperactivity, irritability, restlessness, increased motor activity, and abrupt movements may also be observed. Magnesium facilitates the absorption of calcium. Even a moderate magnesium deficiency may contribute to the development of cardiovascular diseases. Severe deficiency of this mineral can have serious consequences and, as a rule, may lead to myocardial infarction [8,9].



**Figure 1. Macroelement composition of common raspberry (*Rubus idaeus* L.) leaves (mg/kg).**

In addition to macroelements, microelements also perform important physiological functions in the human body. Although they are present in the body in very small amounts, they participate in metabolism, immune function, antioxidant defense, and cellular signaling as components of enzymes, hormones, and biologically active proteins. Deficiency or excessive accumulation of microelements can lead to metabolic disorders and the development of various diseases.

According to the ICP-MS analysis results, the elements Sr, Zn, Ti, Cu, Ni, Mo, Ga, Rb, Li, Sn, V, Zr, As, Ag, Se, Sb, Cd, Nb, Cs, Ge, W, In, Ta, and Re were identified in the leaves of common raspberry (*Rubus idaeus* L.). Their concentrations varied, and their biological significance also differed.

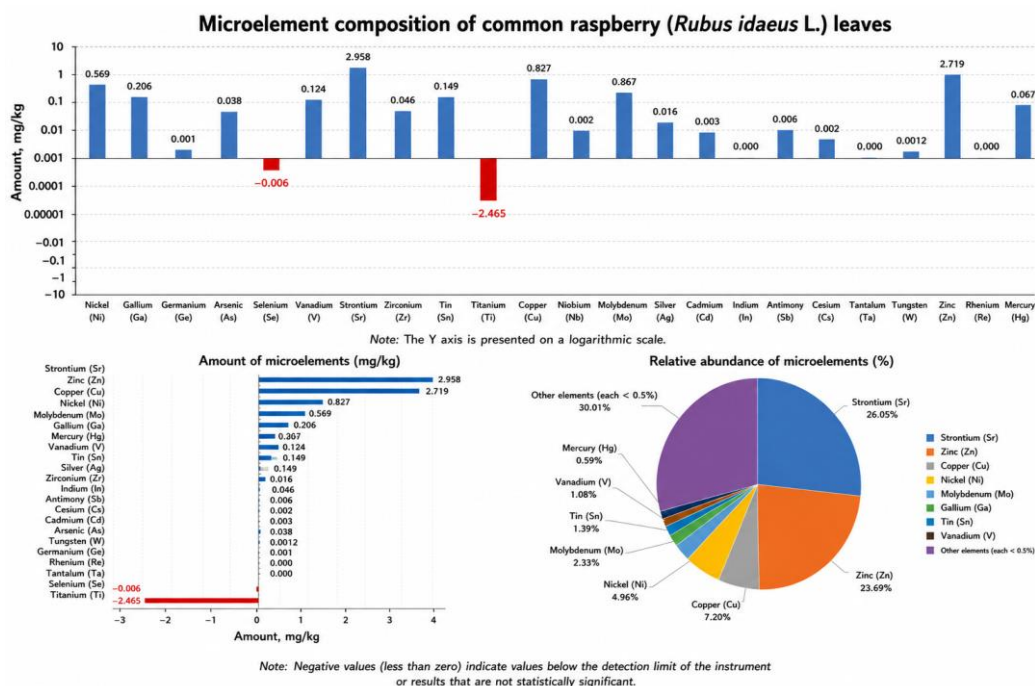
Zinc is a component of more than 300 enzymes in the human body. It plays an important role in DNA and RNA synthesis, cell division, immunity, wound healing, and antioxidant defense. Adequate zinc intake supports effective immune system function. Copper is involved in iron metabolism, hemoglobin synthesis, collagen formation, and the activity of antioxidant enzymes. It is also an essential trace element for the normal functioning of the central nervous and cardiovascular systems.

Molybdenum is a cofactor of the enzymes xanthine oxidase,

sulfite oxidase, and aldehyde oxidase and participates in purine metabolism and detoxification processes. Although the biological role of nickel has not been fully established, it has been reported to participate in the activity of certain enzymes and to influence iron metabolism.

Selenium has strong antioxidant properties and is a component of the enzyme glutathione peroxidase. It plays an important role in neutralizing free radicals and supporting thyroid function and the immune system. Strontium may have a positive effect on the mineralization of bone tissue. Some clinical studies have reported its use in the treatment of osteoporosis.

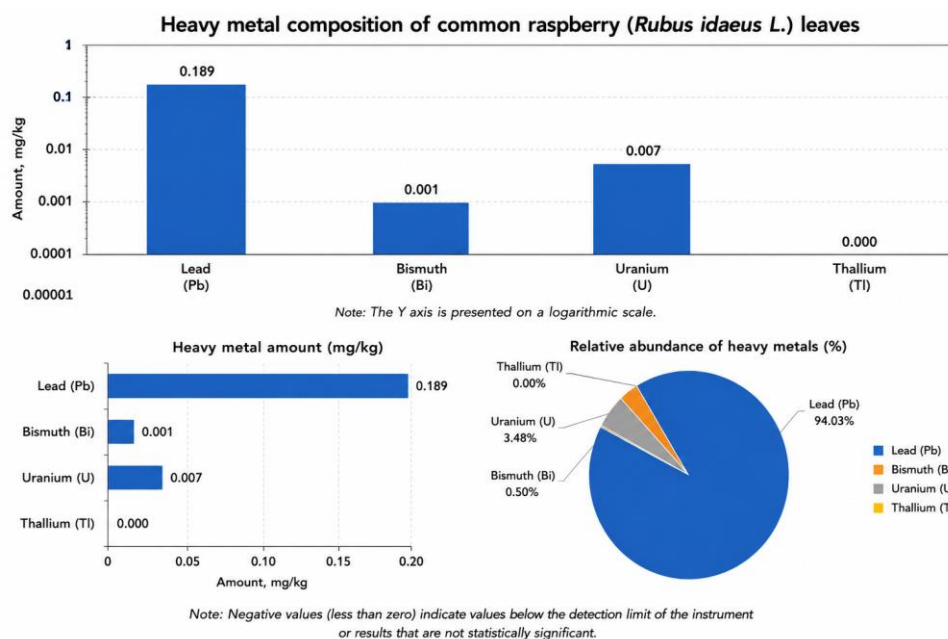
has been indicated for its use. Gallium is being investigated in clinical practice as a promising element for the diagnosis of certain tumors and for the development of antibacterial agents. Other microelements, including titanium (Ti), germanium (Ge), niobium (Nb), tungsten (W), indium (In), tantalum (Ta), rhenium (Re), zirconium (Zr), silver (Ag), and cesium (Cs), occur in plants in very small amounts. Although some of them are not recognized as essential elements for the human body, they are attracting scientific interest in the fields of toxicology, pharmaceuticals, and biomedicine [9].



**Figure 2. Diagrams of the microelement composition of common raspberry (*Rubus idaeus* L.) leaves (amount, mg/kg).**

When determining the elemental composition of common raspberry (*Rubus idaeus* L.) leaves, toxic heavy metals for the human body (lead, cadmium, mercury, and thallium) were assessed according to SanPiN requirements. The amount of these metals was determined in accordance with the requirements of the United Nations Food and

and Agriculture Organization (FAO) and the Joint FAO/WHO Codex Alimentarius Commission as components subject to strict control. The concentrations of toxic heavy metals in the leaves were found to be within the permissible limits established by SanPiN 0193-06 [], indicating that the leaves were collected from uncontaminated areas and are environmentally safe [10].



**Figure 3. Heavy metal composition of common raspberry (*Rubus idaeus* L.) leaves (mg/kg).**

#### **4. Conclusion**

For the first time in Uzbekistan, the elemental composition of the leaves of common raspberry (*Rubus idaeus* L.) grown in Uzbekistan was analyzed using the ICP method. The study identified 40 elements in the investigated sample, including 17 macroelements and 23 microelements. The concentrations of heavy metals in the raw material were found to be within the permissible limits established by SanPiN requirements.

#### **References**

1. State Register of Medicinal Products of the Republic of Uzbekistan [Electronic resource]. — URL: <https://www.pharm.uz/> (accessed: 04.06.2026).
2. State Pharmacopoeia of the Republic of Uzbekistan. — Tashkent: Fan Publishing House, 2020. — Vol. 1.
3. Statistics Agency of the Republic of Uzbekistan. Statistical data on healthcare and pharmaceuticals [Electronic resource]. — URL: <https://stat.uz/> (accessed: 04.06.2026).
4. World Health Organization. WHO Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants [Electronic resource]. — URL: <https://www.who.int/publications/i/item/9241546271> (accessed: 04.06.2026).
5. Smirnova E.V., Kuznetsova N.A. Determination of macro- and microelements in the leaves of medicinal plants by atomic emission spectrometry // Bulletin of Pharmacy. — 2022. — No. 2. — P. 25–31.
6. Petrova I.I., Sokolova M.V. Mineral content in the leaves of *Rubus idaeus* L. // Proceedings of Universities. Applied Chemistry and Biotechnology. — 2023. — Vol. 13, No. 2. — P. 88–95.
7. Ivanov V.V., Petrov A.N. Mineral composition of medicinal plant raw materials and methods for its determination // Pharmaceutical Chemistry Journal. — 2020. — Vol. 54, No. 6. — P. 3–10.
8. Zhang Y., Li X., Wang J. Mineral elements in medicinal plants: analytical approaches and pharmacological relevance // Journal of Pharmaceutical Analysis. — 2021. — Vol. 11, No. 5. — P. 521–533. DOI: 10.1016/j.jpha.2021.03.004
9. European Pharmacopoeia Commission. European Pharmacopoeia. — Strasbourg: Council of Europe, 2023. — 11th ed.
10. European Medicines Agency. Guideline on Bioanalytical Method Validation [Electronic resource]. — URL: <https://www.ema.europa.eu/en/bioanalytical-method-validation> (accessed: 04.06.2026).