Investigation of safety and mineral composition of fresh petioles of *Arctium lappa* L

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Abstract. The range of food stuffs having a rich composition of useful substances can be greatly enhanced by using a great variety of wild plants growing in Siberia. Apart from familiar widely used wild mushrooms, berries and other wild plants a biennial herbage plant, namely, great burdock can be used. Precise requirements to safety of wild plants growing in Russia are not available in regulatory documents. This makes it much more difficult to pass the procedures of confirming the conformity of products. This also has a negative effect on the processes of harvesting, storage, processing and transportation of wild plant raw materials. The key goal of testing the quality of products is to ensure safety of food stuffs. This goal can be achieved by further study of wild plants and by establishing precise standards of safety.

1 Introduction

High-quality and safe food is crucial for life and health of people and the generation to come. In the context of import substitution and increasing competitiveness, it is possible to expand the product range through the use of non-traditional plant raw materials.

Quite a lot of wild plants such as mushrooms, berries and other herbage plants are used in folk recipes. Many of wild plants contain a wide range of bioactive substances and are a source of vitamins, minerals, and fibers. They also possess medicinal properties.

Great Burdock (*Arctium lappa* L) is also used in folk recipes. Roots, petioles, and seeds (soups, salads, etc.) can be eaten. Besides, health-promoting properties and chemical composition of this plant makes it possible to use it to make functional food products. Such countries as China, the USA and Japan have long used this plant in nutrition and cultivate it as a vegetable plant [1, 2, 3]. The nutritional use of various parts of wild great burdock (Fig. 1) is due to a complex of useful substances which have a positive effect on certain systems and functions of the human body [4, 5, 6, 14].

1 is a leaf; 2 is the leaf petioles; 3 is an anthodium; 4 is a root

Fig. 1. Structure of *Arctium lappa* L.

Wild plants can accumulate toxic microelements, nitrates, pesticides and radio nuclides from the soil. The degree of heavy metal contamination of raw materials primarily depends on the environment and soil pollution as a result of human economic activity.

Food plants by accumulating metals from the soil promote their transfer to the human body [7, 8].

The content of lead, mercury, arsenic, cadmium, copper, iron and zinc are controlled in international trade according to the decision of the joint FAO/WHO Commission on the Food Code [7, 9].

Over several years new documents regulating the quality and safety of food stuffs have appeared. For example, in 2016 two State Standards for organic food products were adopted.

These state standards regulate the procedure for certification and requirements for production, sale and labeling of organic products.

Stricter restrictions are imposed on organic produce in contrast to traditional agricultural products in terms of the content of pesticides, agrochemicals, growth stimulators, GMO, etc. Such products are entered in the unified State Register and are labeled by special graphics [10, 11].

However, according to TR CU 021/2011 requirements for the content of heavy metals in wild plants are not specified. Thus, when carrying out investigations the main problem was to compare the results obtained. For example, some researchers when evaluating safety indicators compare the cultivated wild plants with the norms for fruit and vegetables. Criteria of quality and safety assessment for non-cultivated plants are not available [12].

The technical regulations of the Customs Union on food safety regulate the admissible levels of mercury, cadmium, lead and arsenic [12].

Lead is one of the most widespread and dangerous toxic metals. It affects the nervous and digestive systems, as well as muscle and sexual functions. At high concentrations lead is accumulated in the human body and affects blood-making organs and kidneys. The main source of lead in the body is food.

Cadmium is the second heavy metal. It affects sulfhydryl groups of proteins and enzymes and results in aberration of iron and calcium metabolism in the organism. Cadmium is easily absorbed by various organs of the body. Water and food are the main sources of cadmium.

The excess of this toxic metal hampers the DNA synthesis and causes disorder in assimilation and metabolism of such elements as zinc, copper, selenium and iron, which leads to a deficit of these elements in the body. Permanent action of cadmium on the body leads to dysfunction of kidneys, osteomalacia, pulmonary failure and cardiovascular diseases.

Mercury is a highly toxic element. Accumulating in plants and entering the human body the metal inactivates enzymes, which leads to disturbance in copper, calcium, selenium, and zinc metabolism.

Arsenic is an equally toxic metal. It usually accumulates in the roots of the plant and slightly less in its leaves and stems. Arsenic negatively affects the immune system of the human body and causes a violation of redox processes in it, as well as cellular respiration. In large doses, arsenic blocks oxidative processes, which leads to oxygen starvation of the body.

During heat treatment, cleaning, and washing, the lead and mercury content decreases [13]. The exact boundary between harmful and necessary minerals for the body is very conditional.

Calcium has a regulating effect on the nervous system, muscle activity, as well as on the construction of bone. Calcium deficiency leads to bone demineralization, which results in the development of osteoporosis. A lack of this macronutrient strongly affects children and adolescents, causing rickets, growth retardation, scoliosis, blood clotting disorders and many other disorders.

An overabundance of calcium is also a serious problem for the human body. Calcium deposited in the body causes insoluble deposits that settle on the walls of blood vessels, joints, muscles, kidneys, etc. Excess calcium leads to serious disorders in the work of these organs and tissues.

Magnesium is involved in the synthesis of proteins and supports the self-regulation of potassium, sodium and calcium in the body. The macronutrient is necessary for the normal course of various reactions associated with energy metabolism. Magnesium is involved in the synthesis of proteins, normalizes the nervous system and helps to remove some harmful substances from the body.

Magnesium helps to reduce cholesterol in the blood, prevents the formation of kidney stones and supports the normal functioning of the heart muscle. With hypermagnesemia, there is a slowdown and inhibition of muscle and nerve reflexes. Heart work is also disrupted.

Phosphorus is a necessary element that is involved in the mineralization of bones and teeth, as well as in the construction of the cell wall. This macronutrient participates in energy metabolism. It is a part of nucleic acids, nucleotides and phospholipids. Phosphorus deficiency leads to the development of rickets, anemia and anorexia. With an excess, the risk of formation of stones in the organs increases. A prolonged imbalance of phosphorus and calcium can lead to a heart attack.

Sodium and potassium participate in the water-salt metabolism of the body and contribute to the preservation of the composition of biological fluids [14].

Potassium regulates blood pressure, the conduction of nerve impulses, and the activity of myocardial contraction. With sodium deficiency, general weakness, muscle cramps, and headaches can occur. It is involved in the transport of water in the body, muscle contractions, and nerve signals.

The regulatory documents do not regulate the content of such trace elements as zinc, iron, and copper in wild plants, which pose a danger to humans in large quantities

Zinc is a low-toxic element. It is involved in the metabolism and is part of more than 80 enzymes of the body. Lack of nutrition leads to slower growth and impaired sensory functions of the body. The daily requirement is 15 mg, the concentration of zinc above 200 mg / kg leads to poisoning

Iron is involved in the enzyme activity of the body and is part of hemoglobin. The daily requirement for this element is 14 mg. Its higher concentration has a toxic effect.

Copper is a part of the enzyme systems. When exceeding the norm by more than 300 times, it leads to intoxication of the body and a number of human diseases. The daily requirement for copper is up to 1.0 mg

According to the studied requirements for the content of heavy metals, micro and macronutrients in wild raw materials, as well as the lack of separate standards concerning the safety indicators of wild burdock petioles, further studies of the safety indicators of this object of research are required, which confirms the relevance of the chosen topic.

Research objectives are:

- to determine the content of heavy metals in fresh burdock petioles;
- to study the mineral composition of fresh burdock stalks.

2 Objects and methods of research

The object of the study is petioles of the large burdock .- *Arctium lappa* L. = *Lappa major* Gaertn.fresh (Fig. 2)

According to earlier studies, the raw material was collected before the release of the flowering stem in the basal rosette phase. In Siberia, the period of this phase runs from the end of May to the middle of June [14].

In this phase of plant development, basal leaves are formed with juicy petioles up to 40 cm long and up to 3 cm wide. The collection of raw materials was carried out at a distance of 5-10 cm from the level of the soil cover and the length of the petioles was from 15 to 30 cm, while the diameter was 1-3 cm [14].

Fig. 2. Fresh burdock petioles

Irregularly shaped or damaged by insects large burdock petioles were not allowed to be harvested. According to the organoleptic indicators, the color of burdock petioles should be green, the smell should be characteristic of this plant, and the consistency of the petioles should be dense and crisp [14].

In the phase of the basal rosette, relative to other phases of plant development, burdock petioles contained the highest amount of protein -18.02% and sugar-12.63%, and the least amount of fiber - about 20.6 % of absolutely dry substance. One hundred grams of the raw material under study contain 3.1 % fiber and 2.51 % protopectin, so this product can be a source of insoluble dietary fiber [14]. Fiber has a radioprotective property and promotes the elimination of heavy metals from the body.

The content of heavy metals in the burdock petioles was determined by the following methods:

- lead and cadmium – by the method of atomic absorption determination of toxic elements [15],
- mercury – by the method of flameless atomic absorption [16]
- arsenic – by the method of inverse voltammetry on TA-type analyzers [17].

The mineral composition was determined by the atomic absorption method.

In fresh burdock petioles, the potassium content is 18 % of the daily requirement. The actual content of trace elements is shown in Table 4.

3 Research results

To confirm the safety of burdock petioles for food purposes, the content of heavy metals in fresh petioles was studied.

Since burdock is not cultivated in our country and does not belong to vegetable raw materials, the permissible level of heavy metals in feed was accepted as the norm [18] (Table 1).

Table 1. Heavy metals in fresh petioles of wild burdock

Heavy metals	Actual mg / kg	Permissible level, mg/kg
Pb	1,134	5,0
Cd	0,061	0, 3
Hg	0,040	0,05
As	0,005	0,5

Thus, the content of heavy metals in the petioles of wild burdock and their presence in the object under study does not exceed the permissible level for plant objects. Therefore, the raw material is safe for further consumption.

The ash content of burdock petioles is 0.92%. The content of macronutrients in fresh burdock petioles is shown in Table 2.

Table 2. Macronutrient content in fresh wild burdock petioles

Macronutrients	Actual content	Daily requirement, g
Ca	0,17, %	1,0
P	0,12, %	0,8
Na	0,04, г/кг	1,3
K	6,27, г/кг	3,5
Mg	0,18, г/кг	0,4

In fresh burdock petioles, the potassium content is 18 % of the daily requirement. The actual content of trace elements is shown in Table 4.

Table 4. Trace element content in fresh wild burdock petioles

Trace lements	Actual content, mg / kg	Daily requirement,
Fe	9,20	14
Cu	0,70	1
Zn	2,00	15
Mn	1,40	2

Among the trace elements, the largest share is accounted for iron - 9.2 mg/kg, which is 6.6 % of its daily requirement. Manganese and copper make up 7% of the daily value of manganese and copper.

When comparing the mineral composition of burdock petioles, it is possible to notice a higher content of potassium, sodium, magnesium and iron relative to the content of these elements in white cabbage, zucchini, cucumbers and other vegetables by 2-4 times..

The use of wild burdock petioles in recipes of new dishes can successfully compete with traditional types of vegetables, increasing their biological value.

Thus, petioles of wild burdock are a safe source of raw materials for the production of semi-finished products.

4 Conclusions

1. The weak point in the current legislation is the confirmation of the safety of wild raw materials. The adoption of new regulatory documents allowed manufacturers to apply these requirements when conducting voluntary certification procedures. However, this is not enough to ensure a significant level of safety and makes it difficult to procure and sell products made from poorly studied wild plant raw materials.
2. The content of heavy metals in the object under study does not exceed the permissible level; therefore, the raw material is safe for further processing and consumption.
3. While studying the mineral composition substances found in the petioles of burdock is comparable it was found that they were not inferior to many cultivated vegetable plants, and the con-tent of some them is even higher.

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