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The determination of heavy metals in medical plants in georgia

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A B S T R A C T

The aim of this investigation is the determination of heavy metals (lead, cadmium, cooper and zinc) in the medicinal plants grown at the various part of Georgia. For the purposes to use of medicinal plants it is important to determine in them the content of the toxic microelements, especially since the ecological state in the world is changing for the worse. Accumulation of heavy metals in the various parts of plants is particularly important, because extreme demands are placed not only on the content of effective ingredients in these plants but also on their harmlessness. The followingparts of the plants:1. Rhizoma Potentillae, 2. Fructus Foeniculi, 3. Herba Hyperici, 4. Flores Chamomillae, 5. Folia Plantaginis Majoris, 6. Rhizomata et radices were investigated by differential-pulls polarographic method. The results of the study showed that medicinal herbs collected in Georgia have high quality, since one side the content of the toxic element – Pb in them is much lower than acceptable by the international standard and the concentration of Cd is equal to zero. On the other side, concentration of essential microelements – Cu and Zn are normal.

Keywords: Heavy metals, Medicinal grass, Polarographic method, Rhizoma Potentillae, Fructus Foeniculi, Herba Hyperici.

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Introduction

Recent years, interest to medicinal plants has been increased and the potential of their use is in progress. It is well known, that they can be used for various chronic and acute diseases, since they have high biological activity and less toxicity. Metabolic processes occurring during the ontogenesis period of plants form very important and valuable compounds, such as essentialoils, alkaloids, glycosides, tannins, vitamins or other biological active substances that have a mild and long-lasting effect on the human body. For the purposes of use of medicinal plants it is important to establish in them the content of the toxic microelements, especially since the ecological state in the world is changing for the worse. Proceeding from the fact that medicinal plants are used for a long time, a great deal of determination has in them the content of heavy metals as they can accumulate in the human body.

Georgia occupies an interesting geo-botanical position as a part of Caucasia – the region which links Europe with Asia. The country is characterized by rather contrasting natural conditions, which account for the extremely high degree of divergence of plant communities within this comparatively small area. The rich and unique phytogenetic fund of Georgia represents a natural-historical treasure and requires the permanent conservation and rehabilitation, as it progressively exterminates or changes under the influence of various natural disasters. There is spread the unique medicinal, aromatic, melliferous, spicy and poisonous plants in Georgia, among them there are some varieties of plants which are not to be found anywhere in the world [1]. Due to their current state, most of these plants are on the verge of extinction. The erosive processes of genetic resources and uncontrolled export are going on. To all this is added the development of

industrialization, urbanization and construction. Heavy metals have generated several serious environmental problems that they are easy to transfer into soil and water, which will pose extreme toxicity to plants and aquatic organisms. The heavy metals contents of herbal plants are variable due to the factors like differences between the plants species, geographical area and exposure to different pollution sources. It is important with medicinal plants because extreme demands are placed not only on the content of effective ingredients in these plants but also on their harmlessness, including the content of heavy metals, namely Cd and Pb.

In previous years, we investigated the content of heavy metals in the medicinal herbs (*Melissa Officinalis* L., *Salvia Officinalis* L., Flaxseeds and its oil) grown on the own areaofTSMU I. Kutateladze Institute of Pharmacochemistry [2-4].The content of all four metals (Cd, Pb, Zn, Cu) was normal in above mentioned plants.

Current study belongs to study of medicinal plants growing on the outskirts of large cities (Tbilisi and Gori) of Georgia. Namely, the first - village Kiketi, which is located13 km from Tbilisi on the south-east slope of the Trialeti ring; altitude is 1200 m above sea level, with a mild, temperate climate. The second - village Ateni, which is located10 km from Gori on the northern slope of the Trialeti ring; altitude is 730 m above sea level, with a moderately, humid climate.

It is well known, that the plants tissue contents almost all the chemical elements. However, 12 of these elements (C, H, O, N, P, K, S, Ca, Mg, Fe, Zn, Cu) are essential nutrients for all plants [5-7]. They are required for body structure, fluid balance, protein structures and to produce hormones. They are a key for the health of every body system and function, but if their concentration does not meet the generally accepted norm, then they become harmful. The heavy metals As, Pb, Cd and Hg have not any function in the living organism, only are very harmful to plant, animal and human bodies. The main objective of our study was set to determine the quantity of the heavy metals (Cd, Pb, Cu, Zn) in plantsspread in Georgia.The parts of following plants:1.*Rhizoma Potentillae,* 2.*Fructus Foeniculi,* 3. *Herba Hyperici,* 4. *Flores Chamomillae,* 5. *Folia PlantaginisMajoris,* 6.*Rhizomata et radices Inulae*have been investigated by us. The listed medicinal plants are used all over the world and in particular in Georgia from the past centuries. These plants have many medicinal properties such as:

1. *Rhizoma Potentillae* and *its rhizome* extracts have been known for a long time in traditional medicine as a remedy for the treatment of inflammations, wounds, and gastrointestinal disorders. There are 30 species in Georgia and two of them are Georgia's endemic.
2. *Fructus Foeniculi* is very popular in Georgia. Sweet fennel fruit medicines are available in various forms to be taken by mouth. Preparations made from sweet fennel fruit can also be found in combination with other herbal substances. This combination is the essential herbs for hernia of cold type with abdominal pain because of its actions of warming kidney and liver.
3. *Hypericum herb* is used as part of many pharmaceuticals and its medicinal properties have such as: anti-inflammatory, antiseptic, spasmolytic action, stimulates skin regeneration.
4. *Flores chamomile* (Matricariarecutita, also known as Matricariachamomilla or Chamomillarecutita) is one of the best-known medicinal herbs in the world. It has anti-inflammatory, healing, anti-allergic effects. The extract is used in a wide range of cosmetics.
5. *Folia Plantagini*in Georgia there are 11 types. Extract of its leaf is characterized by anti-inflammatory, bactericidal, sedative, anti-depressive action. Used for respiratory tract infections, nervous disorders and insomnia, wounds and ulcers, gastritis, colitis.
6. *Rhizomata et radices Inulae*show a wide range of pharmacological action: anti-inflammatory, antimicrobial, blood-stopping, wound healing. decreased inflammatory process activity in the stomach, decreases the stomach acidity, strengthens the mucous substance .

Objective and Method

The followingparts of the plants:1.Rhizoma Potentillae, 2.Fructus Foeniculi, 3. Herba Hyperici, 4. Flores Chamomillae, 5. Folia Plantaginis Majoris, 6. Rhizomata et radices were investigated by differential-pulls polarographic method with a dropping mercury electrode (t=3.5 s,m=2.6 mg/s) by a three-electrode cell. The analytical procedure included: a careful washing technique by acetone and rinsing many times with redistilled water, drying at the 100°C for an hour, weighing and burning at the 450°C for 5 h in the quartz vessel. The receipted ash was treated by 1 N HNO_3 and evaporated. Af-

ter this 1 N HCI was added and evaporated again. The ash obtained in result of the mineralization of a plant was dissolved in 10 ml of 0.1 N HCI. After this, the solution is placed into the thermostatic cell (t=25°C) and during in 10 minutes is blazing by inert gas. The value of potential was taken towards the saturated calomel electrode potential.

Results and analysis

The results of polarographic analysis of heavy metals content in plants are represented in Fig. (given as an example for *Rhizoma Potentillae*), which shows that each of investigated microelement gives a sharp peak at a certain very specific value of potential, namely, the value corresponding to the half-wave potential of the given microelement for Cu, Pb, Zn $E_{1/2}$ = -0.2V; -0.5V; -1.05V consequently. The peak correspondent of cadmium is absent, because concentration of this metal in the investigated plants from all above mention villages equals zero.

In Table are listed the concentration of 4 metals in all investigated by us in medicinal plants.

On the basis of our investigation it was established, that the toxic metal content in the medicinal plants from the villages near the cities (Tbilisi and Gori) of Georgia does not exceed the limits allowed by World Health Organization [8]. The maximum permissible levels in raw materials of medicinal plants for Cd and Pb are amount of 0.3 mg/kg and 10 mg/kg, respectively. As for Zn and Cu the WHO limits for these metals have not yet been established. It should be noted that the content of copper and zinc varies depending on the plant itself, with which

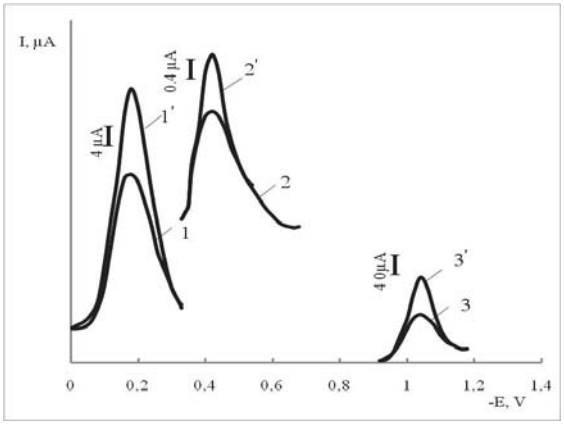

Fig. *Polarograms for heavy metals in 1 g sample of the plant in the supporting electrolyte of 0.1 M HCl: 1 - Cu(II), 2 - Pb(II), 3 -Zn(II); 1,2,3- corresponding standard solutions.*

their various healing properties are apparently related. Zinc is a component of many metal-enzymes, especially some enzymes which play a central role in nucleic acid Metabolism [9]. Zinc is also a membrane stabilizer and a stimulator of the immune response [10]. Manifestations of acute zinc poisoning include nausea, vomiting, diarrheal, fever and lethargy. The estimated safe and adequate daily intake of zinc is between 10.0 and 20.0 μg/day. As well as zinc, copper is essential to the human body since it forms a component of many enzyme systems, such as cytochrome, oxidise and ceruloplasmin, an iron-oxidizing enzyme in blood. The observation of anaemia in copper deficiency may probably be related to its role in facilitating iron absorption and in the incorporation of iron in haemoglobin [11].

Table. *Results of research of the medicinal plants content of ions*

#	Name of the plant	Content, mg/kg			
		Cu	Pb	Cd	Zn
1	HerbaHyperici	31.80	2.63	0.00	96.70
2	Flores Chamomillae	3.01	2.04	0.00	99.98
3	Rhizomata et radices Inulae	29.40	1.60	0.00	65.90
4	FructusFoeniculi	20.10	1.98	0.00	97.70
4	FructusFoeniculi	20.10	1.98	0.00	97.70
6	RhizomaPotentillae	1.50	2.40	0.00	82.90

The maximum permissible level of copper is 12.0 μg/ day. Therefore, the magnitudes of the content of zinc and copper in medicinal plants correspond to the rate necessary for medicinal properties.

The absence of Cd and the low value of Pb in all of by us studying medicinal herbs are logically associated with relatively high levels of Cu and Zn. The absorption and distribution of Cd is usually influenced by low intake of Zn and Cu and contrary. Cadmium has a negative effect on enzymatic systems of cells with its ability to substitute for other metal ions (mainly Zn^{2+}, Cu^{2+} and Ca^{2+}) in metal-enzymes and has a strong affinity for biological structures containing sulfhydryl-groups.

Conclusion

We determined the content of Pb, Cd, Zn and Cu in various parts of plants located proximity to the vehicle big towns (Tbilisi, Gori). The investigation was performed through differential-pulse polarographic method. On the basis of our investigation it was established that the toxic metal content in the medicinal plants content of lead, cadmium, copper and zinc does not exceed the limits allowed by World Health Organization standards. It should be noted that the content of copper and zinc varies depending on the plant itself, with which their various healing properties are apparently related. The results of the study showed that medicinal herbs collected in Georgia are of high quality, since one side the content of the toxic element – Pb in them is much lower than acceptable by the international standard and the concentration of Cd is equal to zero. On the other side, concentration of essential microelements – Cu and Zn are normal.

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