COMPARISON OF INORGANIC CHEMICAL CONSTITUENTS OF DIFFERENT HERBAL MEDICINES

C. Oprea[1], M.V. Gustova[1], O.D. Maslov[1], A.G. Belov[1], I.A. Oprea[1,2], C. Pirvutoiu[1,2], D. Vladoiu[1,2]

[1]*Joint Institute for Nuclear Research (JINR), Dubna 141980, Russian Federation*

[2]*Bucharest State University, 76900, Bucharest, Romania*

Abstract

The microconstituents and also some minor- and macroelements in seven medicinal plants, namely *Achillea millefolium, Chelidonium majus, Cynara scolymus, Hypericum perforatum, Tilia cordata, Matricaria recutita, and Urtíca*, were determined. The above medicinal plant species were used for the experiments as they are an important source of drug with many pharmaceutical effects as well as bioaccumulators of the trace heavy metals and other bioactive chemicals.

The analytical work consisted of the measuring of the elemental concentrations of inorganic specific constituents using instrumental gamma-activation analysis in suite with X-ray fluorescence technique.

Further the results were used to develop an approach for incorporating information on biochemical availability in herbal medicines into practical anthropogenic use.

Introduction

The medicinal plants studied in this work have been administrated currently to cure some diseases in Romania and abroad. Diet is the main source of trace elements. Although the efficacy of herbs for curative purposes is often accounted for in terms of its organic constituents, it has been established that there exists a relationship between the chelating of metals and some chemotherapeutic agents. Herbs can interact directly or indirectly with body chemistry. The chemical compounds of these herbs are mainly responsible for the curative properties. It is known that there is a significant role of trace elements when treating various diseases. The absorption of their active constituents into the blood can influence the body system and these chemical constituents present in the plant are responsible for their curative aspect. Many essential elements play an important role in the plant metabolism products of plant cells. Few studies have been reported about the elemental composition of medicinal plants. The goal of this work was to determine the availability of essential trace elements in commonly used medicinal plants in Romania and their possible correlation from one medicinal herb to another one.

Materials and methods

Sample collection

For each type of herbal medicine, an average sample was prepared by mixing of the 6 samples collected from an area of 50 x 50 m^2. Medicinal plants were purchased in the dried form of root, bark and leaf from local herbalists. Others were collected from national botanical parks situated in the Romanian Carpathians. Each plant was washed extensively in drinking water as to remove superficial dust and then dried by an IR lamp for one day. Prior to analysis the samples were dried at room temperature one month and later 48 hours at 40^0C and then homogenely melted into fine powder in an agate mortar. The fresh/dry mass ratios calculated for herbal material were about 5.78 – 6.32.

Analytical methods

A highly sensitive γ activation method based on the (γ, n) reactions and gamma-ray spectrometry (IGAA) for measuring the elemental concentrations in environmental samples is applied. The powdered samples were packed in polyethylene vials into duplicate. A packet consisting of 10 cassettes with samples and standard samples was irradiated by gamma-rays for 5 h together with flux monitors by a photon flux of 24 MeV at the MT-25 microtron (FLNR, JINR). For the irradiation there was a 7% difference in the flux factors between the upper and lower positions of the container. The overall integrated flux over a 5 hours irradiation is practically constant. The spectra calibration by the use of ^{226}Ra source was done.

Complementary the replicate samples were investigated by X-ray fluorescence analysis (XRF). The spectra of the characteristic X-ray lines were recorded by a Si(Li) X-ray detector having a thickness of 3 mm and an area of 30 mm2. The measured energy resolution of the detector system was 200 eV FWHM at the 5.9 keV Mn K_α line. Another components are the Be window of the detector, the glass sample holder and the protections of Pb and Ag to absorb the Compton scattering effect. Photons of 22.1 KeV from the 109Cd annular source and photons of 59.57 keV from the ^{241}Am annular source were used for excitation of the target X-rays. An Al shield was used in the case of each source to suppress the low-energy photons emitted from the radioisotope. The geometry of ^{109}Cd source was normally versus detection direction and that of ^{241}Am source was such that the incident direction was situated at 530 versus the detection direction.

The analysis of the measured spectra were performed using the SPM software developed in FLNR using a nonlinear least squares fitting routine which approximates characteristic X-ray peaks with Gaussian curves of various types of background depending on the spectrum region and calculates intensities of X-ray peaks.

Results and discussion

A total of 34 elements have been determined in the 7 medicinal plants commonly used in Romania using IGAA and XRF (Table 1). Elemental contents vary in a wide range, in some cases even by an order of magnitude (Figure 1). It can be observed that mean concentrations of Cu, Mn, Rb and Zn are in amounts >10 μg/g whereas of Cr and V are in amounts >1μg/g. Toxic elements as As, Cd, Hg and Sb, are present in quartiles below the permissible limits.

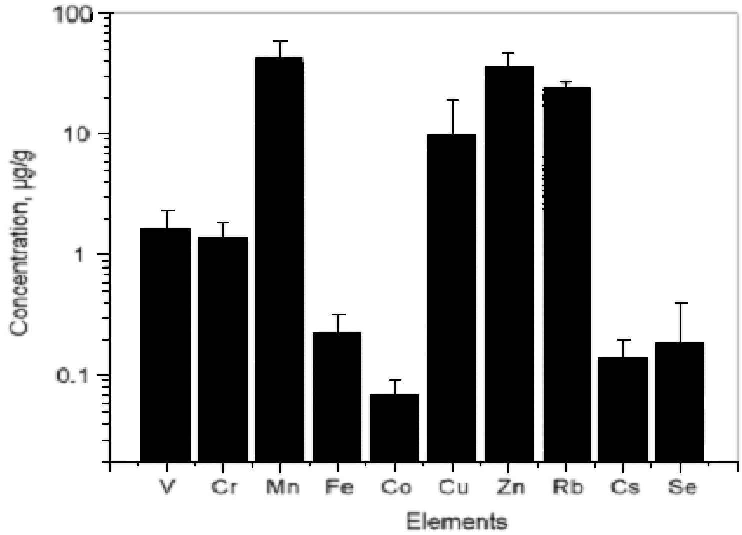

Figure 1. Variation in mean concentration of essential trace elements in medicinal plants

Table 1. Some elemental concentrations in medicinal herbs (% at)

	LT1	LT2	LT3	LT4	LT5	LT6	LT7
K	3.8±0.6	3.1±0.5	3.1±0.5	2.0±0.6	1.9±0.5	4.4±0.7	4.2±0.5
Ca	1.5±0.3	2.5±0.3	2.8±0.3	2.6±0.3	3.1±0.3	6.1±0.4	0.6±0.3
Ti	0.168±0.080	0.372±0.070				0.207±0.074	
V					0.15±0.04		
Mn		0.037±0.010		0.055±0.012	0.041±0.012	0.086±0.015	0.042±0.010
Fe	0.172±0.009	0.192±0.008	0.091±0.009	0.439±0.010	0.040±0.009	0.079±0.010	0.077±0.008
Ni			0.0116±0.0030	0.0140±0.0036		0.0160±0,0036	0.0090±0.0033
Cu	0.0198±0.0028	0.0102±0.0026	0.0114±0.0026	0.0267±0.0031	0.0116±0.0027	0.0074±0.0024	
Zn	0.0126±0.0023	0.0132±0.0023	0.0054±0.0026	0.0104±0.0026	0.0221±0.0026	0.0107±0.0028	0.0060±0.0020
Pb	0.0015±0.0008	0.0018±0.0008	0.0017±0.0009	0.0029±0.0010		≤0.0012	
Se	≤0.0005		0.0013±0.0005	0.0023±0.0006			0.0009±0.0004
Br	0.0062±0.0004	0.0012±0.0004	0.0012±0.0005	0.0195±0.0005		0.0016±0.0004	
Rb	0.0011±0.0003	0.0013±0.0003	0.0009±0.0003	0.0041±0.0004	0.0033±0.0003	0.0014±0.0004	0.0012±0.0003
Sr	0.0037±0.0003	0.0047±0.0003	0.0072±0.0003	0.0092±0.0003	0.0054±0.0003	0.0185±0.0003	0.0042±0.0003
Y	0.0010±0.0003	0.0008±0.0003	≤0.0003	0.0009±0.0003	≤0.0004	≤0.0003	
Zr	0.0025±0.0003	0.0009±0.0002	≤0.0003	0.0064±0.0003	≤0.0005	0.0018±0.0003	≤0.0005
Nb	≤0.0002	≤0.0002		0.0008±0.0002			
Mo						0.0006±0.0003	0.0005±0.0002
Pd				0.0008±0.0003			
Ag			0.0016±0.0003			≤0.0004	
Cd						≤0.0004	
In	0.0015±0.0004		0.0006±0.0004	0.0011±0.0003	0.0028±0.0005	≤0.0004	
Sn	0,0009±0.0003			0.0008±0.0003		≤0.0004	0.0027±0.0004
Sb							0.0010±0.0004
Cs		0.0018±0.0004					
Ba	0.0023±0.0004	0.0059±0.0005	0.0035±0.0004	0.0079±0.0004	0.0008±0.0004	0.0033±0.0005	0.0024±0.0005
La		≤0.0003	≤0.0003	0.0027±0.0004	≤0.0003	≤0.0004	0.0018±0.0005
Ce			0.0019±0.0004	0.0027±0.0004	≤0.0005		

Bar plots of the all essential trace elements V, Cr, Mn, Fe, Co, Cu, Zn, Rb, Cs and Se exhibit large variations with Co (being in least amount) and Mn (the highest). This variation in elemental concentrations may be explained by the differential uptake by the plant from the soil or due to inherent nature of the plant species grown in that region.

There are interrelationships of various elements in plant species (Figure 2). K/P ratio exhibits a mean value of 8.5±0.55 and lies in the range 6.73 – 10.2. Also, Cu and Zn (r=0.74) exhibit consistent correlationship, indicating a suitable balance of biochemical processes and consequently potentially contributing to a good health.

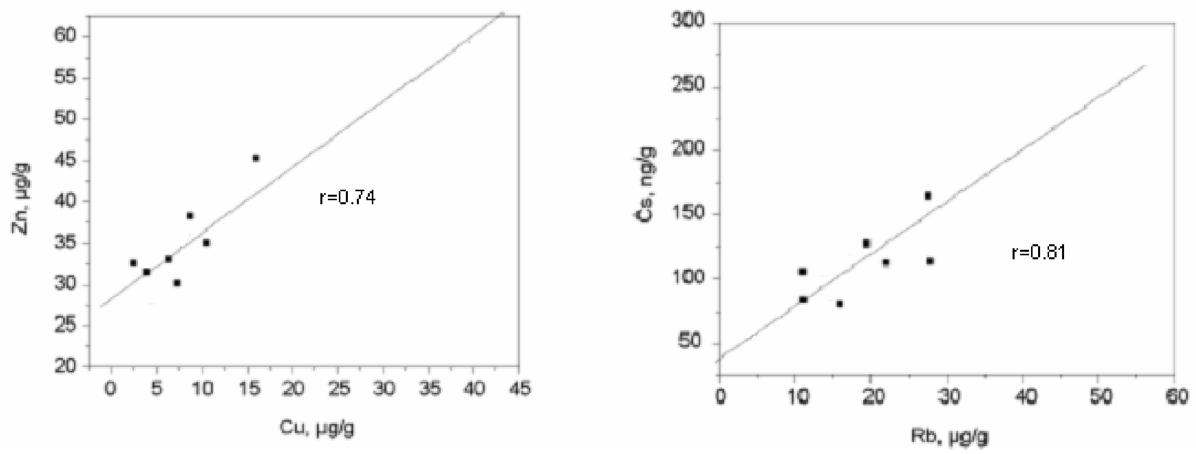

Figure 2. Correlations Zn - Cu and Cs - Rb in *Achillea millefolium*

Experimental data obtained for the minor, essential and toxic elements content in medicinal herbs can be used to evaluate their potentiality for the improvement of human health.

Conclusion

Leaves, roots, fruits and seeds of seven medicinal plants have been analyzed for 5 minor (Na, K, Ca, Mg and P) and 21 trace (s, Ba, Br, Cd, Ce, Co, Cr, Cs, Cu, Eu, Fe, Hg, La, Mn, Ni, Pb, Rb, Sb, Sc, Se, Sm, Th, V and Zn) elements by IGAA and XRF.

Results show that the application of the combination of the two analytical methods allows a realistic determination of the elemental content of the investigated herbal medicines with good detection limits and accuracy for the low level concentrations. The present work will be developed into an approach between elemental content as therapeutic probability as well as when they are used as basic materials for the development of drugs for the pharmaceutical industry.

References

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