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Medicinal plants in view of trace elements

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Abstract: The use of herbs in different indication fields is well known. The beneficial properties of plants may due to their organic agents and inorganic mineral elements. Measurement of trace element content in plant drugs may be relevant in view of e.g. human health, animal health and environmental relations. This fact has a great significance since about half of the plant drugs available in the trade originate from natural habitat. The element content of herbs may refer to soil pollution, soil type on which the plant grow up or air pollution.

Keywords: microelements, herbs

Introduction

The trade and application of herbs show continously increasing tendency. In Hungary more than 200 plant species official in the Hungarian Pharmacopoeia and more than 300 plant species are used in traditional folk medicine. One part of the plant drugs available in the commercial networks are collected from natural habitat and the other part of the plants are cultivated. This rate generally 50-50 %.

The organic compounds and main bioactive agents of plants are generaly known but the element composition and concentration of elements are unkown in most cases. Or if we know some data on them, there is no exact way for the evaluation.

The determination of microelement content is important in view of plant, animal and human health, and environmental aspect as well. Therefore, the measurement of toxic, essential and non-essential elements in plant drugs may be significant in environmental, toxicological and phytotherapeutical aspect (LESKO et al. 2002; SAGIROGLU et al. 2006, SZENTMIHÁLYI et al. 2005; SZŐKE & KÉRY 2003).

This paper presents some data on microelement content in medicinal plants and possibilities for the evaluation of trace element content.

Material and methods

Plants

Drugs of medicinal plants were obtained from the commercial network and herbs were collected in natural sources or botanical gardens in Hungary and Transylvania between 1989 and 2005. Drugs originated from commercial network were *Cichorium inthybus* (1989, Herbária), *Galega officinalis* (1991, Herbária), *Matricaria chamomilla* (1992, Herbaház). Collected plants and plant parts were in cases of *Lavendula officinalis, Grindelia robusta, Hibiscus abelmoschus* (Botanical Garden of University of Medicine in Tirgu Mures, Transylvania, 1996 and 1999) and *Calendula officinalis* (Botanical Garden, Budapest, Hungary, 1998). *Aesculus hypocastanum*, *Alchemilla vulg*aris, *Corylus avellana, Rhamnus frangula* and *Urtica dioica* were obtained from natural habitat of Tirgu Mures, Transylvania (1996 and 2000), while *Cichorium intybus* and *Taraxacum officinallis* were gathered from Budakeszi (Hungary), in 1995 and 2005. *Helianthus tuberosus* was cultivated in a vegetable garden in Tirgu Mures, Transylvania, in 1995. For the chemical investigation the air dried plant parts of collected plants were used.

Determination of microelement content

Concentrations of the elements of samples were determined by ICP-OES (inductively coupled plasma optical emission spectrometry). Type of instrument: AtomScan 25 (Thermo Jarrell Ash Co.). *Sample preparation for element measurement*: plant material (0.5 g) was digested with HNO_3 (5 ml) and H_2O_2 (3 ml). After digestion, the samples (three parallel) were diluted to 25 ml from which the elements were determined in three parallel measurements.

Statistical calculations

The results were expressed as means and standard deviations. One way analysis of variance (ANOVA) was used for comparing the results between groups. Significance level was determined as $P<0.05$.

Results and discussion

Element content of plants are different according to the species and of same species varied according to the soil, climate and other factors. For example the microelement content in herba of *Urtica dioica, Lavendula officinalis* and

Grindelia robusta growing on the same soil and year is significantly different (P<0.05) for most of the elements (Al, B, Ba, Cr, Cu, Fe, Mn, Mo, Ti, V and Zn) as can be seen in Tab. 1.

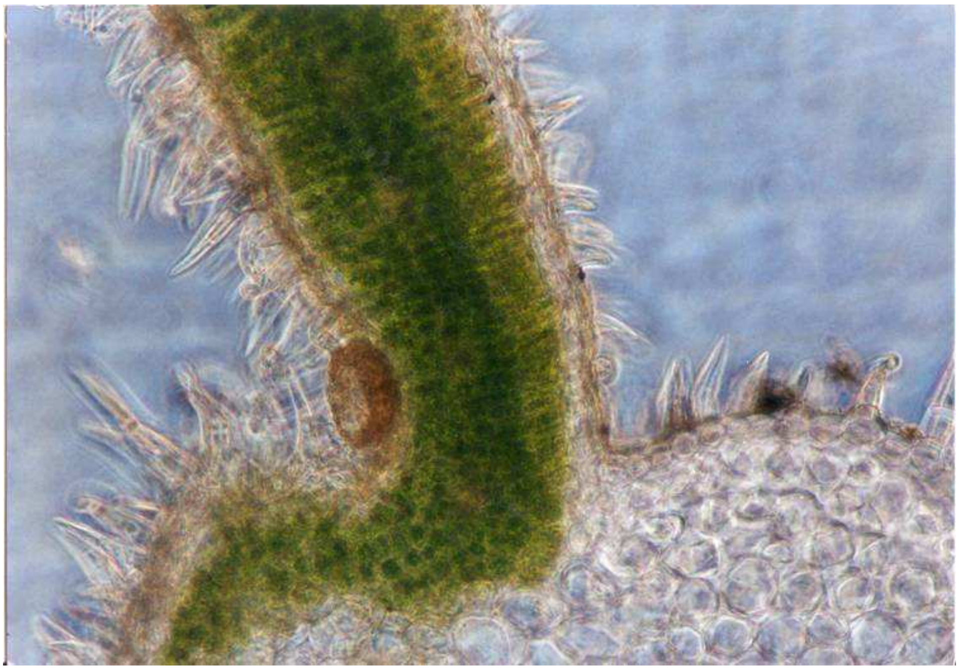

Fig. 1. Grandular hair of Lamiaceae with 8-celled head.

Phytotherapy may recommend different plant parts of the same species for different applications as phytotherapeutical effect may change according to the plant species and plant part. The organic agents of the plant parts may be very different and the microelement content of the different parts of plant drugs also varies (STEFANOVITS-BÁNYAI et al. 2006; SZENTMIHÁLYI et al. 2005) The microelement content of different plant part of *Cichorium intybus* is summarized in Tab. 2. Since microelement content in plant depends on several fact, e.g. climate, microlement content in soil, soil type, etc., for the sake of the comparativeness the samples originate from the same area at different time of the same year. Significant difference was found for Al, As, B, Ba, Cr, Cu, Fe, Mn, Ni, Ti and Zn concentrations between the plant parts. The results are comparable with the average element concentration or normal range of plants: Al < 200 mg/kg, As <2 mg/kg, B 15-100 mg/kg, Ba <100 mg/kg, Cd 0.005-0.2mg/kg, Co 0.02-1 mg/kg, Cr < 1 mg/kg, Cu 12-30 mg/kg, Fe < 300 mg/kg, Mn 20-200 mg/kg, Mo 0.1-2 mg/kg, Ni 1.1-10 mg/kg, Pb <2 mg/kg, Ti <2 mg/kg, V 0.02-1.5. mg/kg and Zn 20-200 mg/kg (COLAK et al., 2005; DIVRIKLI et a.l., 2006; KABATA-PENDIAS & PENDIAS, 1984; PAIS, 1984; SZENTMIHÁLYI, 1987).

Tab. 1. Microelement content (mg/kg dry weight, n=3) in different plant drugs originated from Transylvania at 1996

	Herba			Dried leaves	
Elements	*Urtica dioica*	*Lavendula officinalis*	*Grindelia robusta*	*Aesculus hypocastanum*	*Corylus avellana*
Al	476.8±6.3.8	130.7±4.1	1425±7.0	204.8±5.3	263.0±3. 3
As	3.63±1.60	<dl	<dl	<dl	<dl
B	48.27±1.23	29.53±0.16	81.46±0.60	20.01±0.84	41.78± 0.53
Ba	67.03±1.91	15.79±0.12	12.55±0.08	9.80±0.19	13.26± 0.19
Cd	<dl	<dl	<dl	<dl	<dl
Co	<dl	<dl	<dl	<dl	<dl
Cr	1.56±0.28	0.822±0.069	1.92±0.07	0.788±0.296	0.50 4±0.180
Cu	12.09±0.21	7.86±0.49	13.44±0.16	11.10±0.20	7.62± 0.82
Fe	443.3±3.2	136.7±1.50	1075±12	294.1±2.5	280.0±3.0 0
Mn	52.73±0.21	17.50±0.09	60.02±0.52	82.56±1.05	208. 6±2.1
Mo	1.14±0.77	<dl	0.666±0.250	<dl	<dl
Ni	<dl	<dl	<dl	<dl	<dl
Pb	<dl	<dl	<dl	<dl	<dl
Ti	32.20±0.27	9.97±0.10	37.16±1.34	19.64±0.09	7.93± 0.17
V	1.08±0.06	<dl	2.05±0.61	0.601±0.026	0.986±0.030
Zn	95.70±0.38	7.33±0.23	103.6±0.18	31.31±0.90	24.84 ±0.74

<dl below detection limit

If we evaluate the element content of plant drugs in most cases we know nothing on the soil or habitat they grow up. During the digestion we pay attention to the unsoluble remaining material which could be silicic acid from the plant or soil pollution. In the second part the element content of plant also shows the pollution. The joint occurance of typical soil forming elements as Al, Cr, Fe and Ti in higher concentration then the normal range indicates the soil pollution of the drug or may refer to plant growing on soil with acidic pH (KABATA-PENDIAS & PENDIAS, 1984). Frequently roots are polluted (Tab. 3) although sometimes aerial parts of the plant drugs may contain these elements over the average concentration as can be seen in Tab. 1 in case of *Urtica dioica* and *Grindelia robusta*.

Other elements in high concentrations in plant may refer to high concentration of the element in soil. For example high As concentration in plant may show that the soil contain high As. This is not a very specific thing in the Carpathian basin since here there are arsenic containing soils of geological origin.

Tab. 2. Microelement content (mg/kg dry weight, n=3) in different part of chicory (*Cichorium intybus*) collected in Budakeszi, 1995

Elements	Young leaves	Young shoot	Root	Herba	Flower part	Leaves
Al	1159±15	446.3±5.9	484.9±5.3	99.01±5.26	102.6±4.3	426.8.3±8.9
As	7.75±0.12	5.35±0.17	2.06±0.33	2.24±0.12	2.20±0.59	4.24±0.14
B	46.57±2.50	40.59±3.39	21.57±0.85	30.98±0.81	36.60± 1.44	98.10±2.71
Ba	9.87±0.14	7.72±0.11	8.85±0.02	6.19±0.18	6.19±0.18	16.25±0.13
Cd	<dl	<dl	<dl	<dl	<dl	0.043±0.026
Co	<dl	<dl	<dl	<dl	<dl	0.564±0.067
Cr	15.19±0.09	9.67±0.20	5.79±.1.29	7.72±0.89	1.14±0 .02	2.82±0.21
Cu	43.07±0.64	41.31±0.34	53.27±56	17.99±0.24	22.30± 0.29	15.87±0.45
Fe	1609±23	638.2±3.6	868.9±2.2	166.8±0.50	155.2±1.2	492.0±3.2
Mn	63.01±0.41	31.32±0.3.81	35.89±0.18	41.60±0.732	43.16±0.14	135.2±1.3
Mo	<dl	<dl	1.32±0.06	1.38±0.07	<dl	7.04±0.44
Ni	0.87±0.21	0.96±0.18	1.75±0.14	4.80±0.13	0.75±0.0 2	1.34±00.57
Pb	<dl	<dl	<dl	<dl	<dl	<dl
Ti	7.88±0.28	1.98±0.46	12.71±1.66	4.57±1.32	7.08±0. 61	0.76±0.28
V	2.81±0.25	1.27±0.02	1.68±0.41	<dl	<dl	1.99±0.19
Zn	50.07±0.36	33.59±0.17	34.48±0.35	57.29±0.54	42.0 0±0.44	97.71±0.62

<dl below detection limit

Tab. 3. Concentration of Al, Cr, Fe and Ti (mg/kg dry weight, n=3) in some root

Elements	*Helianthus tuberosus*	*Hibiscus abelmoschus*	*Cichorium intybus*	*Taraxacum officinalis*
Al	489.2±0.7	2114±34	910±134	3203±62
Cr	1.89±0.08	4.35±0.21	3.97±0.47	22.40±0.64
Fe	430.4±7.3	1289±6	963±19	2554±116
Ti	16.31±2.77	36.14±1.02	9.52±0.45	27.34±0.53

Industrial waste also could increase concentration of some elements as Cd or Ni.

Typical environmental pollutant is Pb, the concentration of wich may indicate the air pollution. Sages and other Lamiaceae species are good plants for measure this since they have trichomes on the leaves (Figures 1-4). The grandular and covering hairs on the surface of the sage leaves may stick the pollutant which could not be removed by washing. Therefore sage samples frequently contain Pb in higher concentration than 2 mg/kg.

Fig. 2. Grandular hair of *Salvia nemorosa* in the moment of pushing out of volatile oil.

The higher concentration of toxic elements in plant drugs, e.g. As or Pb, may be dangerous, since the elements are dissolved in the extracts and may get into the human and animal body (ALVAREZ-TINAUT et al. 1980, MATTINA et al. 2006).

The elements in the plants may contribute to the favourable therapeutic effect. The plant drugs recommended in folk medine for the diabetes therapy contain Cr in higher concentration (CASTRO 2001) then the average plant concentration < 0.2 mg/kg as can be seen in Tab. 4.

Tab. 4. Cr concentrations in some medicinal plants used in diabetes (n=3)

Medicinal plant drug	Medicinal plant (mg kg^{-1} dry weight)
Seeds of *Aesculus hippocastanum*	0.788±0.296
Burk of *Rhamnus frangula*	2.39±0.33
Herba of *Galega officinalis*	2.55±0.26
Flower of *Matricaria chamomilla*	0.78±0.01
Herba of *Alchemilla vulgaris*	2.53±0.23
Flower of *Calendula officinalis*	1.56±0.54
Leves of *Calendula officinalis*	3.72±0.36

Fig. 3. Grandular hair of *Salvia verticillata*.

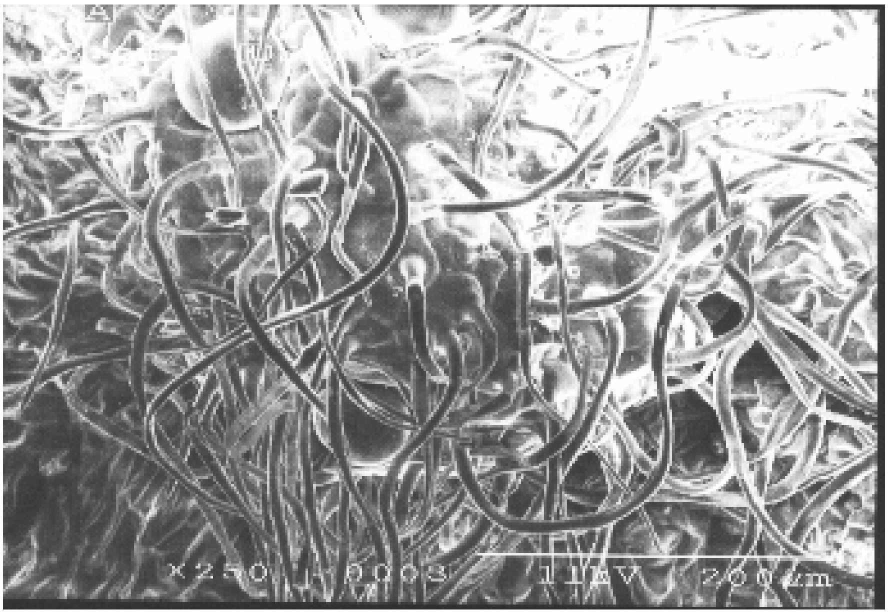

Fig. 4. Scanning electron picture of covering trichomes of *Salvia officinalis*.

Conclusion

The measurement of element content in medicinal plants is important in several point of view. The most significant things are the examination of cleanness of plant by determination of concentration of toxic elements and by determination of presence of soil forming elements in high concentration.

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