MICROELEMENTS IN DRUG AND EXTRACTS OF *PLANTAGO LANCEOLATA* L.

Mária Rábai[a,b], Nóra Veronika Nagy[a], Zoltán May[a], Klára Szentmihályi[a]

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Plantain (*Plantago lanceolata* L.) is a popular medicinal plant for its beneficial effect for respiratory and other antiinflammatory diseases. As the metal ions have significant role in inflammatory processes and antiinflammatory effect, the element content of plantain drug and in extracts has been determined. Element content in drug and different extracts (decoctum and infusum) was measured by inductively plasma optical emission spectrometry (ICP-OES) after nitric acid digestion. Most of the elements in drug had average concentration, except Al, Ba, Ca, S, Sn, Sr and Ti concentration that crossed their average level. Significant difference was found in the concentration of Al, Ba, Ca, Co, Cu, Fe, K, Mg, Mn, Na, S, Sr and V between decoctum and infusum. In most cases concentration of elements was evidently higher in decoctum samples, than in infusum. In conclusion decoctum is a richer source of elements than that of other extracts and generally these teas are relevant sources for several elements (Ca, Co, Cu, K, Mn).

* Corresponding Authors
Fax: +36-1-438-1139
E-Mail: szentmihalyi.klara@ttk.mta.hu
[a] Institute of Materials and Environmental Chemistry Research Centre for Natural Sciences of the HAS, H-1025 Budapest, POBox 17, Hungary
[b] Budapest University of Technology and Economics Budapest, Hungary

INTRODUCTION

At present different herbs and medicinal plant products are widely spread all over the world. They are traditionally tested for centuries, evidently they are the healthiest medicines ever. These days antibiotics are not so popular as they were a few decades ago. Their "Adverse", effects are also visible. Leading a healthy way of life is becoming more and more important, that's why bio foods and natural medical products are preferred by most of the people, especially medium-aged and younger ones.

As these products are not real medicines, earlier they were not needed follow the strict qualifying requirements. Only their origin, expective effect, recipe and the time of warranty can be seen on the package. There is still an enormous problem with regulating herbs. Their double standard principle caused an unbalanced distribution. According to the Hungarian Medicine Codex (Pharmacopoeia Hungarica) and the European Pharmacopoeia there is a limit for organic components, but at the point of inorganic compound it is a bit incomplete. [1, 2] There is a strict quality and quantitative limitation just for the toxic heavy metals. On the other hand only the inorganic components are examined in the Hungarian Victual Codex (Codex Alimentarius Hungaricus)[3], and it is much more strict than the previous formulate. As herbs are classified in both, the medicine and foods, it is to be discussed that which guideline should be followed. Generally the concentration of toxic or non-essential elements was not determined, as they could also be poisonous to human organism.

That's why a new law is still under consideration in Hungary, which is influenced by the European Union. According to it, herbs are also qualified as medicines.

In result of this requirement herbs are also be tested and proved their efficiency. Though it may improve the safety of these products to consume them, but most of these products would disappear from the market, because the qualifying requirements need a lot of time and investments to get the good results, due to which the cost would also increase. Determining the plant samples have got a great difference so it is an important and challenging task to solve. [4]

Present article is about testing ribwort plantain (*Plantago lanceolata* L.). It is also well known as Englishman's foot, broad-leaved plantain, Cuckoo's Bread, the leaf of Patrick, Patrick's dock, ripple grass, St. Patrick's leaf, slan-lus, snakebite, snakeweed, waybread, waybroad, (Anglo Saxon) weybroed, white man's foot. [5] This plantain is originated from the Plantaginaceae. It can be found beside acres, pastures and commons. Its small, white flowers are blossomed from April until June. Its mature leaves are used for therapeutical values. Mucous, tannin, favonoids, silica, zinc, potassium salts and irinoids are located in the leaves. Due to the presence of irinoids, akubin agent, this plant is a powerful bactericide, anti-inflammatory and wound-healer herb. Extracts made of it is used for cough and respiratory diseases. It is an excellent antidote against heartburn, respiratory rheum and sore throat. [6]

EXPERIMENTAL

Materials

Leaves of the ribwort plantain (*Plantago Lanceolata* L.) were produced by Herbária Patikája. Trade from the producting series of 07533-07534, K-101/111.

Aqueous extracts

Two different kinds of aqueous extract (teas); decoctum and infusum were examined.

Infusums were made from 1 g ribwort plantain and 20 mL hot distilled water. Four different extracts were made: drug soaked in hot water for 5, 10, 15 and 20 minutes. After the reaction time was over, they were filtered and stewed for 1-2 hours.

Decoctum was made by the same procedure as infusum. The only difference was the amount of drug (2.5 g in 50 mL water), and the 5 minutes boiling instead of soaking.

Measurement of elements

Element concentration (Al, As, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Ni, P, Pb, S, Si, Sn, Sr, Ti, V, Zn) of the samples was determined with an ICP-OES (inductively coupled plasma optical emission spectrometer). Type of instrument: Spectro Genesis ICP-OES (Kleve, Germany). After digestion of the samples (0.5 g from drug, 20 mL of evaporated extracts) with a mixture of nitric acid and hydrogen peroxide (10 + 4 mL) and dilution with deionised water to 20 mL (extracts) or 25 mL (drug), concentration of elements was determined. [7]

Statistical analysis

Mean values and standard deviations (SD) were calculated from the results obtained. One way analysis of variance (ANOVA) was used for comparing the means of the four groups. To determinate the difference between two groups, the Student *t*-test was used by GraphPAD software version 1.14 (1990). Significance was determined as $P<0.05$.

RESULTS

The element concentration in ribwort plantain is shown in Table 1. The concentration of As and Pb was under the detection limit, therefore these elements are omitted from the table. In ribwort plantain drug a little bit higher concentration was measured in case of Al, Ba, Ca and S above the average level. [8, 9] Strontium concentration was found to be double the amount of the average amount (40 mg/kg).[8] The other elements were at the normal intervallum of concentration (Table 1). [9, 10]

The aqueous extracts of ribwort plantain did not contain As, B, Cr, Pb, Sn and Ti concentrations above the detection limit. The concentration of most elements (Tables 2 and 3) are similar to other data found in extracts earlier, while concentration of Ba, Ca, K, Na, Mn seems to be relevant compared to other aqueous extracts. [7,9,10]

Surprisingly the time of the „reaction" (= time of soaking) wasn't in direct proportion with the element content (Table 2). In most cases the element concentration in infusums are mainly depend on time of soaking and several significant difference was found between infusums calculated by Student t-test. A rising tendency can be observed in respect of Ba, Ca, K, Mg, Na, Ni, P, S, Sr and Zr content till 15 minutes of soaking. Then from 15 to 20 minutes the concentration of most elements was decreased except of Co. Significant difference of the element contents can be observed for Ba, Ca, Cu, Fe, K, Mg, Na, Ni, P, Sr and V in the comparison of four extracts by ANOVA ($P<0.05$). According to these results we can conclude that the time of soaking greatly affect on the element content in infusum.

Table 1. Element concentrations (mg/kg, ± standard deviation, *n*=3) in ribwort plantain (*Plantago lanceolata* L.)

Elements	Mean ± standard deviation (mg kg^{-1})
Al	375.2 ± 62.6
B	40.84 ± 20.88
Ba	44.71 ± 2.67
Ca	16154 ± 150
Cd	0.164 ± 0.029
Co	0.465 ±0.055
Cr	1.50 ± 0.47
Cu	13.57 ± 1.82
Fe	278.7 ± 42.9
Mg	4518 ± 22
Mn	49.60 ± 6.00
Na	997.1 ±-25.1
Ni	0.735 ± 0.132
P	4634 ± 21
S	3218 ± 115
Si	193.9 ± 73.3
Sn	8.63 ± 2.70
Sr	96.16 ± 6.00
Ti	6.06 ± 0.67
V	0.544 ± 0.139
Zn	18.28 ± 1.46

Concentration of Ba, Ca, Co, K, Mg, Sr and V are remarkably raised in decoctum (Table 3) compared to infusum made with soaking for 20 min (Table 2), however Cu, Na and Zn were decreased. Element content of Al, Mn, Ni, P, S and Zn was nearly the same as it was in the 15-20 minutes infusums (Tables 2 and 3). Boiling a sample for 5 minutes is almost the same as soaking it for 15-20 minutes time in respect of many elements. In case of other minerals making a decoctum is the way to get a richer solution. (Tables 2 and 3). Most of the element concentration in decoctum significantly different to infusums except of Ba, Cu and P (Table 3).

The dissolution rate of drug into the different extracts can be seen on the Table 4. Generally the 15 minutes infusum solved the elements in the highest amount. Boiling reduces the tripping of the Cu, Na and Zn while helps other elements extracting. The dissolution into the aqueous extracts is relatively high (>50%) for Co, Cu and Na in all cases, while the dissolution of Fe from drug into the teas was found to be very low (1.67-6.35%).

DISCUSSION

It is demonstrated that ribwort plantain (*Plantago lanceolata* L.) is a valuable medicinal plant in respect of mineral constituents. A generally higher amount of elements were found in decoctum (5 min) than in infusum (5 min). These elements are Co, K, V and some alkaline earth metals, like Mg, Ca, Ba and Sr.

Table 2. Element concentrations (mgL^{-1}, ± standard deviation, n=3) in aqueous ribwort plantain infusum extracts (*Plantago lanceolata* L.)

	Element content in Plantago Lanceolata aqueous extract (mg L^{-1} ± SD)				ANOVA, calculated for four infusums (P<0.05)
	Infusum 5 min.	Infusum 10 min.	Infusum 15 min.	Infusum 20 min.	
Al	1.34 ± 0.29	0.874 +/ -0.022	1.44 ± 0.36	0.934 ± 0.070	Not sign.
Ba [b ,f]	0.257 ± 0.030	0.267 +/ -0.050	0.332 ± 0.030	0.268 ± 0.200	Sign.
Ca [a, b, d ,f]	127.0 ± 8.6	141.0 ± 33.1	185.2 ± 13.4	143.6 ± 14.2	Sign.
Co	0.008 ± 0.001	0.008 ± 0.003	0.0096 ± 0.0020	0.0096 ± 0.0020	Not sign.
Cu	0.196 ± 0.009	0.172 ± 0.004	0.232 ± 0.035	0.211 ± 0.020	Sign..
Fe [b, d ,f]	0.293 ± 0.290	0.116 ± 0.060	0.443 ± 0.230	0.210 ± 0.050	Sign.
K [b, f]	795.6 ± 41.8	821.1 ± 210.7	961.7 ± 41.8	830.3 ± 25.4	Sign.
Mg [a, b, c, f]	27.23 ± 0.97	31.61 ± 7.69	41.76 ± 3.23	33.95 ± 3.27	Sign.
Mn [b]	0.658 +/ -0.260	0.558 ± 0.13	0.715 ± 0.070	0.586 ± 0.050	Not sign.
Na [a, b,d,e f]	15.66 ±1.84	15.68 ± 5.14	19.13 ± 1.13	15.55 ± 0.99	Sign.
Ni [c]	0.0023 ± 0.0008	0.0112 ± 0.003	0.0155 ± 0.0060	0.0068 ± 0.0030	Sign.
P [a, b, c, d, f]	38.65 +/ -4.79	43.44 ± 9.22	58.33 ± 2.25	51.12 ± 3.40	Not sign.
S [a, b, d, f]	25.90 ± 2.21	28.26 ± 6.65	39.54 ± 1.45	29.46 ± 3.06	Sign.
Sr [a, b, d, f]	0.558 ± 0.040	0.611 ± 0.140	0.820 ± 0.067	0.648 ± 0.060	Sign.
V [a, d]	0.0068 ± 0.0020	0.0020 ± 0.0003	0.0061 ± 0.002	0.0034 ± 0.0010	Sign.
Zn [d, e]	0.0363 ± 0.0300	0.117 ± 0.0002	0.180 ± 0.103	0.102 ± 0.050	Not sign.

[a] significant difference between infusum 5 min and infusum 10 min, [b] significant difference between infusum 5 min and infusum 15 min, [c] significant difference between infusum 5 min and infusum 20 min, [d] significant difference between infusum 10 min and infusum 15 min, [e] significant difference between infusum 10 min and infusum 20 min, [f] significant difference between infusum 15 min and infusum 20 min (Student t-test, P<0.05)

Table 3. Element concentrations (mgL^{-1}, ± standard deviation, *n*=3) in aq. ribwort plantain decoctum extracts (*Plantago lanceolata* L.)

	Element content (mgL^{-1} ±SD)	Significant difference by Student t-test (P<0.05)			
	Decoctum 5 min.	between infusum 5 min. and decoctum	between infusum 10 min. and decoctum	between infusum 15 min. and decoctum	between infusum 20 min. and decoctum
Al	1.02 ± 0.32	Sign.	Sign.	Sign.	Not sign.
Ba	0.423 ± 0.040	Sign.	Sign.	Not sign.	Sign.
Ca	196.3 ± 38.7	Sign.	Sign.	Not sign.	Sign.
Co	0.0119 ± 0.0010	Sign.	Sign.	Not sign.	Not sign.
Cu	0.102 ± 0.025	Sign.	Sign.	Sign.	Sign.
Fe	0.322 ± 0.080	Not sign.	Sign.	Sign.	Sign.
K	1093 ± 23	Sign.	Sign.	Not sign.	Sign.
Mg	47.55 ± 7.76	Sign.	Sign.	Not sign.	Sign.
Mn	0.682 ± 0.080	Not sign.	Not sign.	Not sign.	Not sign.
Na	8.3938±5.56	Sign.	Sign.	Sign.	Sign.
Ni	0.0016 ± 0.0010	Sign.	Sign.	Sign.	Sign.
P	55.64 ± 2.56	Sign.	Sign.	Not sign.	Not sign.
S	38.80 ± 2.58	Sign.	Sign.	Not sign.	Sign.
Sr	0.952 ± 0.060	Sign.	Sign.	Not sign.	Sign.
V	0.0082 ± .-0002	Sign.	Sign.	Sign.	Sign.
Zn	0.0948 ± 0.0300	Sign.	Sign.	Sign.	Not sign.

Table 4. Dissolution rate of drug into extracts (%)

	Infusum 5 min.	Infusum 10 min.	Infusum 15 min.	Infusum 20 min.	Decoctum 5 min.
Al	14.33	9.32	15.37	9.95	10.88
Ba	25.22	26.13	32.49	26.23	41.42
Ca	31.45	34.92	45.85	35.56	48.60
Co	68.85	68.85	82.62	82.62	102.41
Cu	57.89	50.67	68.36	62.11	29.98
Fe	4.21	1.67	6.35	3.01	4.63
Mg	31.38	35.27	46.29	37.74	39.60
Mn	53.92	45.70	58.59	48.02	55.87
Na	62.84	62.89	76.73	62.37	33.67
Ni	12.52	60.97	84.38	37.02	8.71
P	33.36	37.50	50.35	44.13	48.03
S	32.20	35.13	49.15	36.62	48.22
Sr	23.20	25.42	34.12	26.93	39.60
V	50.03	14.71	44.88	25.01	60.33
Zn	40.57	24.03	39.15	34.95	17.66

Consuming extracts made of this medicinal plant as a medicine helps us to get an appreciable part of the essential minerals. A tea is said to be a fine element source if 15 % of the Recommended Dietary Allowances (RDA) is covered by its well-defined amount of consumption. [11] According to this, drinking 1 litre of any kind of extract made of this drug contains and supports 15.9-24.5% of Ca, 27.6-41.4% of Co, 39.0-54.6% of K and 27.5-35.7% of Mn (RDA: 800 mg for Ca, 0.029 mg for Co, 2000 mg for K and 2 mg for Mn per day[11]). Infusums were also found to be good Cu sources with 17.2-32.2% of RDA, while decoctum covers only the 10% of RDA. It is worthy to mention that extracts made of ribwort plantain contain 1/3 of the daily Al intake (Dietary Reference Intakes [12]).

In conclusion ribwort plantain plant is a unique herb, which contains a lot of necessary elements. This plantain is available easily and economically to every one Thanks to the nature for its excellent compositions and its relevance to be a valuable source for several elements. It can also be favourable to use in preventions and symptomatic treatments as well.

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