Evaluation of minerals in two varieties of *Dictamnus albus* L.: the white variety (cv. *Albiflorus*) and the purple variety (cv. *Purpureus*)

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S u m m a r y

The composition and contents of the selected macro- and microelements present in the soil and different organs of two varieties of dittany (*Dictamnus albus* L.), white (cv. *Albiflorus*) and purple (cv. *Purpureus*) were determined. On average, the purple variety contained higher contents of iron, manganese, zinc and copper, whereas the higher contents of nickel and cadmium were found in the white variety.

Key words: dittany, Dictamnus albus L., Albiflorus, Purpureus, HPIC, ion chromatography, minerals.

INTRODUCTION

The effects of minerals on plants is a subject of a great number of experiments. Agrotechnical methods based on adding such minerals to fertilizers in order to improve plant crops are widely known [1, 2]. A currently recommended list of elements participating in the vital activities of plants includes the following macroelements: Na, Mg, Ca, P, K, S, and the following microelements: Fe, I, F, Cu, Mn, Zn, Co, Se, Cr, as well as some trace elements: Si, V, Sn, Ni, As, Li, Br, Ba. On the other hand, Hg, Pb and Cd are regarded as toxic elements with known embryotoxic, teratogenic, mutagenic and carcinogenic properties. Plants may accumulate different metals in the amounts depending on various factors, for example the soil composition, environmental contamination and the type of a plant organ [2-6].

The aim of the performed research was to evaluate the composition and the contents of selected macro- and microelements present in the soil and in different organs of two varieties of dittany (*Dictamnus albus* L., family *Rutaceae*): the white variety (cv. *Albiflorus*) and the purple variety (cv. *Purpureus*).

MATERIALS AND METHODS

The research material included the soil and above-the-ground, as well as under-the-ground parts of two varieties of *D. albus* coming from experimental plots of the Faculty of Ornamental Plants of the Academy of Agriculture in Lublin.

Soil examination

The contents of nitrate nitrogen, phosphorus, potassium, calcium, magnesium, copper, zinc, manganese and iron were assayed in soil samples collected in May 2001 from experimental plots of the Academy of Agriculture in Lublin. The analyses were carried out in accordance with the guidelines [7, 8] in the Chemical and Agricultural Research Station in Lublin.

Macroelement assays in the plant material

Dried and ground plant samples weighing 1 g were burnt to ashes in the electric oven at the temperature of approximately 500°C. A few drops of water and 5 ml of diluted HCl were added to the ashes and then they were filtered through filters without phosphorus and supplemented with redistilled water up to 100 ml. The contents of phosphorus, potassium, calcium and magnesium were assayed in the obtained solutions. The measurements were repeated three times, and each time a new sample was analysed. The phosphorus content was evaluated spectrophotometrically, following the reaction with ammonium vanadate and ammonium molybdate; the contents of potassium, magnesium and calcium were evaluated by means of flame photometry, while the nitrogen content with the method described by Kiejdahl [7].

Microelement assays in the plant material

Samples of different plant parts (flowers, herbs, roots) weighing 1 g were ground and following the addition of 6 ml of nitric acid (Suprapur) and 4 ml of deionised water were mineralised in a teflon bomb (micronizer UniClever, Plasmotronica BM-1Z). The resulting solutions were diluted with deionised water up to 100 ml and injected on the chromatographic column in order to perform assays in order to determine the amounts of the following microelements: iron, copper, zinc, cadmium, manganese and nickel. The chromatographic analysis (HPIC) was performed with a Dionex DX 500 (USA) ion chromatograph combined with a spec-

trophotometric detector and with post-column derivatization on-line. The analysis conditions were as follows: an IonPac CS5A column, an IonPacCG5A precolumn, the mobile phase: pyridine-dicarboxylic acid (PDCA) + formic acid + potassium hydroxide + potassium sulphate + deionised water, derivatizating reagents: 4-(2-pyridilazo)-resorcinol (PAR) + dimethylaminoethanol + sodium bicarbonate + ammonium hydroxide, the flow rate of eluent was set at 0.3 ml/min, the flow rate of derivate 0.15 ml/min and the injected volumes were 100 μl.

RESULTS AND DISCUSSION

The soil is the main source of the trace elements for plants. These elements may also be assimilated by leaf blades from rain.

In Table 1 we have presented the results of assays for the macro- and microelements present in the soil of experimental plots where *D. albus* was grown.

Table 1

The content (in mg per kg of dry weight) of the macro- and microelements in the soil.

elements	content/ SD (n=2)
$N\text{-}NO_3$	32 ±6
P	161 ±3
K	160 ±1
Mg	91 ±9
Ca	600 ±30
Zn	13.96 ±0.28
Mn	37.6 ±9.2
Cu	4.64 ±0.31
Fe	99 ±15.8

As it can be concluded from the presented data, the examined soil had the highest contents of calcium and phosphorus and the lowest contents of zinc and copper. These results are comparable to the results of examinations of other soils. In natural conditions the contents of the trace elements are greatly diversified, depending on the species and varieties of plants, as well as vegetation conditions [9].

The results of assays for the macroelements present in different organs of two varieties of *D. albus* are presented in Table 2.

Table 2

The macroelement content (in mg per kg of dry weight) in different organs of two varieties of *D. albus* (SD n = 3).

plant parts		*cv. Albiflorus*			*cv. Purpureus*		
		flowers	herbs	roots	flowers	herbs	roots
elements	N	210.7 ±3.3	170.2 ±1.2	174.9 ±3.1	198.4 ±3.1	174.6 ±4.5	182.7 ±3.3
	K	201 ±2.0	208 ±4.0	9 ±0.7	192 ±2.4	204 ±3.3	12 ±1.5
	P	35 ±1.5	25 ±0.22	24 ±1.2	31 ±1.3	43 ±2.1	24 ±1.8
	Ca	20 ±0.7	296 ±2.3	197 ±3.8	52 ±2.7	338 ±6.3	304 ±5.3
	Mg	10 ±0.1	22 ±1.3	6 ±0.24	12 ±1.1	22 ±3.3	6 ±0.7

Nitrogen and potassium are the main macroelements in flowers and green parts of both varieties of *D. albus*; however, small amounts of potassium were also found in roots. Unlike flowers, green parts and roots of both varieties contain high calcium contents, especially high in the case of the purple variety of *D. albus*. The results of the assays for the microelements are presented in Table 3.

Table 3

The microelement content (mg/kg dry wt.) in different organs of two varieties of *D. albus* (SD n = 3)

Element	cv. *Albiflorus*			cv. *Purpureus*		
	flowers	herbs	roots	flowers	herbs	roots
Fe	171.3 ±4.7	81.35 ±1.2	132.4 ±2.1	236.7 ±3.0	84.57 ±0.9	171.24 ±2.2
Cu	1.53 ±0.08	0.01 ±0.0	0.01 ±0.0	1.9 ±0.09	0.01 ±0.0	0.01 ±0.0
Zn	56.32 ±1.6	62.29 ±2.1	18.62 ±0.8	51.2 ±1.2	73.69 ±1.1	39.03 ±0.9
Cd	0.58 ±0,1	0.01 ±0.0	0.01 ±0.0	0.29 ± 0.1	0.01 ±0.0	0.01 ±0.0
Mn	19.58 ±0.5	53.63 ±1.4	64 ±1.2	27.4 ±0.4	38.97 ±1.8	100.1 ±1.3
Ni	0	0	0.80 ±0.1	0.37 ±0.01	0	0.73 ±0.01

As it can be concluded from the data shown in Table 3, iron, zinc and manganese are the main microelements present in different part of two varieties of *D. albus*, whereas copper, cadmium and nickel are present in lower contents.

Iron

The iron content in plants depends on the plant species and age. In general it is about 100-300 mg/kg (mg/kg of dry matter), but it may range from about fifty mg/kg to several thousands ppm [2]. In the case of *D. albus* the highest iron content was found in roots, especially in the purple variety, whereas the lowest content was detected in flowers.

Manganese

According to many scientists, the manganese content in plants may range from 50 to 200 mg/kg in dry matter, depending on the plant species and its organ, its age, pH of the soil, humidity etc. [10]. Manganese is not evenly distributed within the plant. In general, leaves contain more manganese than other plant parts. Not only the manganese content itself but also an appropriate ratio to other minerals, especially the Fe:Mn ratio is important in order to provide plants with manganese. In the case of insufficient manganese content the concentration of divalent iron in the plant may be too high or too low. When this ratio is higher than 2.5:1 the symptoms of manganese deficiency which are identical to symptoms of iron excess might develop. However, when the Fe:Mn ratio is lower than 1.5:1 plants suffer from manganese excess, what simultaneously indicates iron deficiency [10]. Our experiments led to a conclusion that in *D. albus* this ratio is 1.7:1 in the white variety and 1.8:1 in the purple variety.

Zinc

The zinc content in plants depends on the plant species and plant supplies of available zinc forms and it ranges in normal conditions from 20 to more than 200 mg/kg [2]. Zinc is strongly connected with nitrate metabolism of plants. It is necessary for the synthesis of tryptophane [5, 11] which is a precursor in alkaloid formation [4]. According to our research, the mean zinc content in the purple variety of *D. albus* was 54.64 mg/kg, whereas in the white variety the value was 45.74 mg/kg. A relatively high zinc content in *D. albus* may affect the alkaloid formation in the plant.

Copper

According to literature data, the copper content in plants ranges from 1 to 20 mg/kg. The metal stimulates for example the accumulation of different flavonoids, especially anthocyanins [11]. Its highest content was found in flowers of both varieties, especially in the purple variety, which may be explained by the fact that copper forms links with anthocyanins responsible for the flower colour.

Nickel

The nickel content in plants usually ranges from 0.1 to 5 mg/kg [10]. According to the performed experiments, the presence of Ni was found in flowers and roots of the purple variety and in roots of the white variety.

Cadmium

The low cadmium content was found in flowers of both varieties. However, in other plant samples only trace contents of this element were present.

Figures 1 and 2 show mutual contents in percentages of different metals in the examined material. It should be emphasized that the iron content, expressed in per cent, in different organs of both varieties increases from flowers to roots, whereas the zinc content decreases in the same direction. In general, the purple variety contained higher contents of iron, manganese, zinc and copper, whereas in the white variety the higher contents of nickel and cadmium were observed. According to the performed experiments, the contents of the selected elements present in *D. albus* were appropriate for a normal development of the plant.

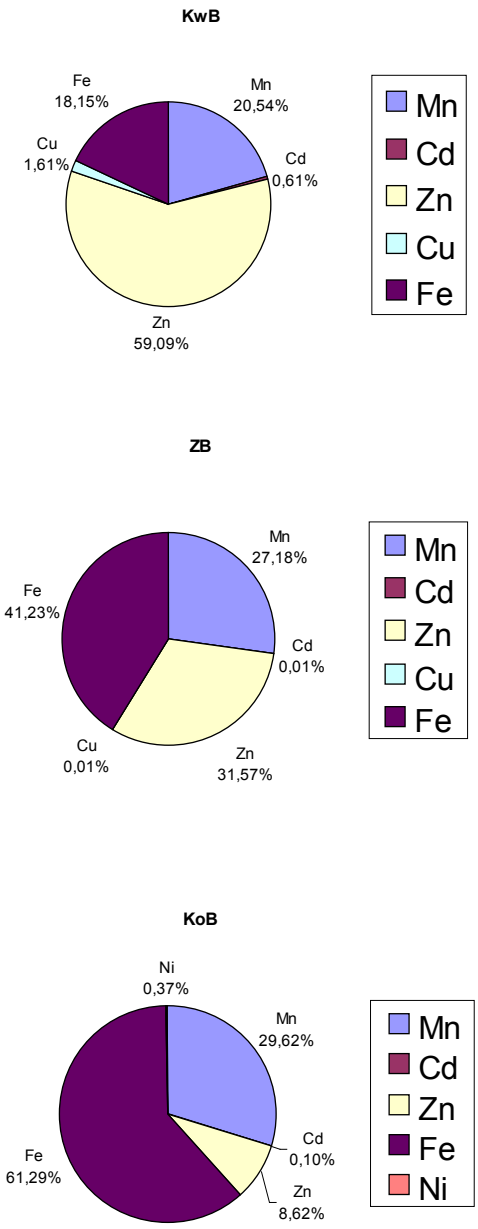

Figure 1. The relative ratios (in per cent) of microelements in the white variety of dittany. Cv. *Albiflorus*: KwB – flowers, ZB – herbs, KoB – root.

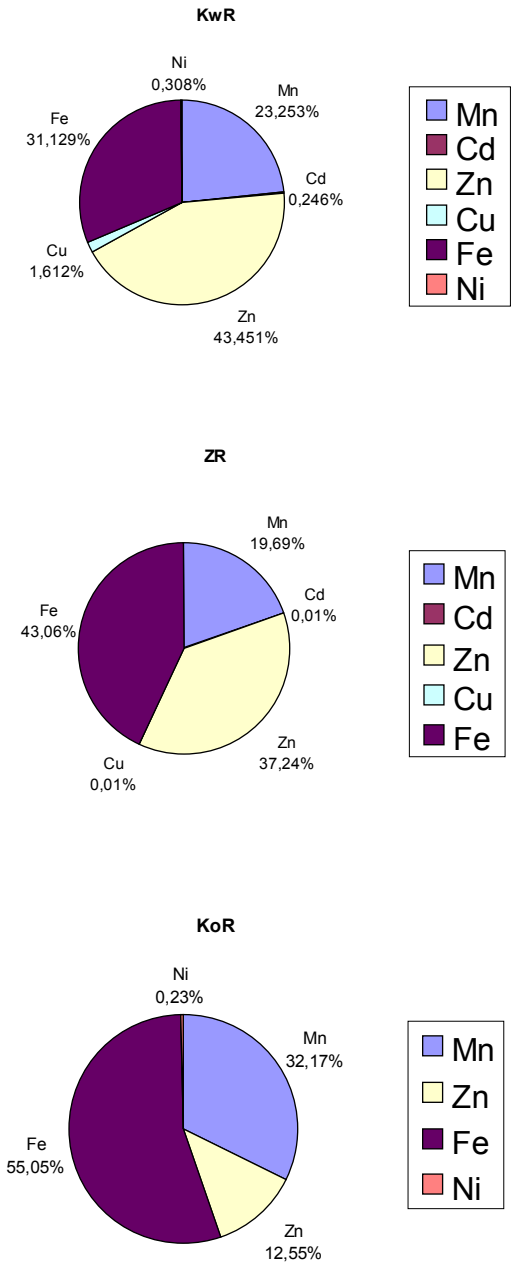

Figure 2. The relative ratios (in per cent) of microelements in the purple variety of dittany. Cv. *Purpureus*: KwR – flowers; ZR – herbs, KoR – root.

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OCENA ZAWARTOŚCI SKŁADNIKÓW MINERALNYCH W DWU ODMIANACH DYPTAMU JESIONOLISTNEGO (*DICTAMNUS ALBUS* L.) – BIAŁEJ (CV. *ALBIFLORUS*) I RÓŻOWEJ (CV. *PURPUREUS*)

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S t r e s z c z e n i e

Określono skład i zawartości wybranych makro- i mikroelementów występujących w podłożu glebowym oraz różnych organach dwu odmian dyptamu jesionolistnego (*Dictamnus albus* L.) – białej (cv. *Albiflorus*) i różowej (cv. *Purpureus*). Odmiana różowa zawierała na ogół większe ilości żelaza, manganu, cynku i miedzi, natomiast w odmianie białej stwierdzono większe ilości niklu i kadmu w badanych organach.

Słowa kluczowe: dyptam jesionolistny, Dictamnus albus L., mikroelementy, makroelementy, HPIC, chromatografia jonowa