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Full Length Research Paper

Environmental impact of site location on macro- and microelements in Tansy

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Human activities cause specific impact on the enveronment, which also could been monitored by mineral contents in the soil and in the plants. Two different caracteristic locations had been selected for the experiments: anthropogenic-Ada Huja contamineted industrial zone and non anthropogenic-Topcider park area. The contents of macro- and microelements is measured in the soil and conseqently in the plant. Correlation between the contents of minerals in the soil and its adsorption by the plant was found, as well as mineral contents in the different locations, depending on the environmental conditions and antrophogenic factor. Tansy (*Tanacetum vulgare* L.) had been choosen as a substantial and wide spread plant on both locations. The usefulness of that easily accessable plant had been analysed with respect to its mineral contents. Human beings decrease utilization and edibility of Tansy plants in contaminated environment and this is proved and quantified in this paper by the contents of macro- and microelements (S, P, K, Ca, Mg, Na, Fe, Si, Al and Mn) contained in them.

Key words: *Tanacetum vulgare*, environmental impact, site location, major elements, trace elements.

INTRODUCTION

Anthropogenic influence on surroundings is reflected in the amount of macro- and microelements in soil and plants. Extensive industrial production is usually connected with the emission of various pollutants to the environment (Kalandadze, 2003). Due to industrial contamination, the amount of macro- and microelements in soil affects plants' qualities.

Urban habitats under influence of people lost characteristics of primary type of soil. The human influence is manifested in the creation of embankments and landfills, disposal of construction materials and land abuse. Therefore, physio-chemical characteristics of urban soil were significantly changed. Urban soil is thus characterized by large fluctuations of physio-chemical properties in a short distances.

Urban plants, due to absence of competition in the changed and extremely conditions, often represent the first pioneer species on anthropogenically modified habitats. Urban flora and vegetation is one of the youngest and most dynamic floristic-vegetative complex. In addition, many of these plants produced various secondary substances, the purpose of defence and protection of these habitats, and among them feticide. Also, these plants absorbed different particles and harmful compounds in urban areas. Specific morpho-anatomical and physiological-biochemical characteristics are the result of plants adaptation on environmental conditions.

Trace elements play an important role in the metabolism of the healthy and diseased plants. The presence of trace elements in sugarcane plants gives a clear picture of the distribution of these elements in the soil where plants absorb essential and necessary trace elements from the soil (Velmurugan et al., 2009). It gives an idea about the structure and composition of the soil, sugarcane plant and sugar products (Mohamed, 1999). The cane plant takes up its need of trace elements from the surrounding soil. The presence of large concentrations of these elements before planting and subsequent lowering of the concentrations after planting in soil samples at 30 cm depth indicate that the plant at this depth absorbs the trace elements. This may be ascribed to the release of the exchangeable cations and anions from the soil solution at this depth and their adsorption by the plant (Bowling, 1976). It only signifies that plants interact with their local environment, namely air, water

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and soil (Connolly and Jellison, 1997). Some micronutrients' deficiencies in soil is one of yield limiting factors (Rakkiyappan et al., 2002).

The contamination of the environment has significant implications for reduced usability and application of field crops for consumption purposes. The most dangerous and prevailing contaminants include heavy metals (Ciecko et al., 2005; Kabata-Pendias and Pendias, 1999; Alloway, 1990). Their high concentrations in the soil exerts negative effects on the growth and development of plants, evoking disturbances in the absorption, transport and assimilation of individual elements and contributing to changes reflected in reduced yields and fluctuating contents of some micro- and macroelements (Gambus and Gorlach, 1992; Obata and Umebayashi, 1997). Zinc and copper belong to the group of elements whose minimal doses are indispensable for the proper functioning of organisms and excessive amounts exert detrimental effects (Pederson et al., 2002). Plants usually demonstrate a high tolerance towards increased contents of metals, however, excessive concentrations of metals in the soil are harmful to plants due to the ease of their accumulation, which is likely to result in diminished volume and deteriorated quality of yields (Davis and Beckett, 1978; Wyszkowski and Wyszkowska, 2003). Tansy is a common and wide spread plant in Serbia. It can be cultivated and it also grows spontaneously. Tansy (*Tanacetum vulgare* L.) was selected for laboratory research since it belongs to urban flora and vegetation where the imperative to adapt is high.

Production of essential oil by Tansy is an indicator of plant adaptation on habitat conditions (Stevovic et al., 2009). Ecological role of essential oils is reflected in the interaction of plants with environmental factors. It helps plant to easily adapt to the environmental stress conditions: drought, intense radiation, high temperature and heavy metal contents (Abu-Darwish and Abu-Dieyeh, 2009).

Nutritional value had been investigated on palm (Ezieshi and Olomu, 2007), *Amaranthus* (Akubugwo et al., 2007) and in other plants. Macro and microelements as well as essential oils in plants are not constant in the qualitative and quantitative terms during the time of change in accordance with the requirements of the environment and to individual survival (Jackson et al., 2003).

The aim of this research was to determine the degree of environmental contamination by the contents of macro- and microelements in soil and Tansy plants on two characteristic site locations. One very contaminated industrial zone (anthropogenic Ada Huja zone) and the other non-polluted park area (non anthropogenic Topčider zone).

MATERIALS AND METHODS

Soil macro and micro-elements analysis

Soil was collected from 25 - 30 cm depth under the Tansy roots. Soil texture was determined by the Bouyoucos hydrometer method. The total nitrogen was measured using a semi Micro-Kjeldhal technique. The available P was determined with spectrophotometer by using Olsen method. The available K was determined by ammonium acetate extraction at pH 9. Sodium (Na), potassium (K), magnesium (Mg), calcium (Ca), aluminum (Al), silicon (Si), iron (Fe) and manganese (Mn) were determined by flame atomic absorption spectrophotometry (AAPS) in the device manufacturing Perkin Elmer (USA) model 403 with Deuterium Background Correction. Phosphorus was determined spectrophotometrically in the form of blue molybdite-vanadium spectrophotometers produced by Carl Zeiss (Germany) model Specol 10 and total sulfur (organic sulfur and sulphates- SO_4^{2-} - which calculate the sulfur trioxide SO_3) was determined in the form of barium sulphate (6, 5). Aluminum and silicon was separated merging with sodium metaborate.

Soil samples (about 1.5 kg) were dried, ground to fine powder and homogenized (the largest particle size about 0.1 mm). The samples were collected from 10 different places (about 1.5 kg/each place) of both site localities.

Plant macro and micro-elements analysis

Whole Tansy plants were collected from two different ecological habitats: anthropogenic-Ada Huja contaminated industrial zone and of major and non anthropogenic-Topcider park area. The plant reaches a height of 150-200 cm at that time. Tansy was growing on damp hill and waste materials on Ada Huja and next to the Topcider River in Topcider Park. Plant materials were harvested at the end of August in three different places on each locality. The sample size was 10 plants per the place. Fresh mass of one plant was approximately 300 g. Plants were 3 times harvested during the one flowering season. Total sample size was 90 per the site locality. Fresh plant material was air dried between the sheets of porous paper, for about a month. All subsequent investigations were made with this prepared material marked as "air-dry matter". They were ground to fine powder using pestle and mortar.

For the determination of total N, 150 mg of the plant powder was digested in concentrated H_2SO_4 following Automated Kjeldahl method. The digested product was diluted to 100 ml and the resulting ammonium was then measured using FIA (Flow Injection Analysis) method. Ca, Fe, K, Mg and P were determined by boiling 2.5 g of the powdered leaf material in concentrated HNO_3. Excess acid was decanted and the boiled sample was diluted to 25 ml. The elements were then determined using ICP OES (Inductivity Coupled Plasma Optical Emission Spectroscopy) method.

RESULTS

Soil samples collected from Ade Huja had pH 8.2. However, pH value measured on Topcider was 7.2. The contents of macro- and microelements in the soil and Tansy plants were expressed in percentage of dry weight. Concentration of total sulfur in the soil sample from Topcider (0,06%) was two times higher than the Ada Huja (0.03%) site location (Table 1). The concentration of phosphorus indicates that the Ada Huja (0,01%) was poor of these elements, while Topcider soil (0.06%) was rich. Also, soil samples from Topcider had 6 times more P than samples from Ada Huja (Table 1).

The soil originating from Ada Huja is mostly composed of sand, while soil from Topcider is a mixture of humus and sand. Soil samples from Topcider consists of more levels of S and P than soil samples from Ada Huja; soils

Table 1. Content of macro- and microelements in soil samples from Ada Huja and Topcider site locations.

Element	Content (%)		
	Ada Huja	Topčider	Range
S	0.03	0.06	0.05 - 0.40
P	0.01	0.06	0.02 - 0.15
K	0.26	0.25	0.2 - 3.0
Ca	6.35	1.00	0.2 - 2.0
Mg	0.20	1.00	0.1 - 1.0
Na	3.50	3.04	1.0 - 3.8
Fe	1.02	0.51	0.5 - 4.0
Si	74.80	28.31	20.0 - 45.0
Al	11.80	6.54	5.0 - 8.0
Mn	0.05	0.06	0.1 - 1.0

Each data is mean of three replicates.

from both site locations contained similar amount of potassium (0.26 and 0.25%) and natrium (3.50 and 3.04%) (Table 1).

Therefore, soil samples from the Ada Huja had six times more of Ca, two times more of iron, silicon and aluminum than soil samples from Topcider (Table 1). However, soil samples from the Topcider had five times more of magnesium than samples from Ada Huja.

Also, mineral elements' contents were measured in Tansy plants from anthropogenic-Ada Huja contaminated industrial zone and non anthropogenic-Topcider park area. Concentrations of sulfur in shoots (0.22%) and roots (0.40%) of plants from Topcider was two times higher than the concentration in plants from Ada Huja (0.11 and 0.20%) site locations (Table 2).

Similarly, amounts of phosphorus in shoots (0.78%) and roots (0.37%) of plants from Topcider were 6 times more than in Tansy from Ada Huja (0.12 and 0.06%) (Table 2). However, Tansy plants from Ada Huja and Topcider had similar amounts of K in shoots and roots, Na and Mn as shown in Table 2.

Moreso, shoots and roots of Tansy plants from Ada Huja had five times of Mg, two times of Ca, Fe, Si and Al than plant samples from Topcider (Table 2). Tansy plants adapted to extreme concentrations of Ca in soil from Ada Huja. Plants adsorbed Ca in optimal concentarations for normaly methabolism.

This work confirmed that Tansy plants absorbed more Ca, Fe, Si and Al due to higher concentrations of these minerals in Ada Huja soil. Soil samples from Ada Huja and Topcider had characterized and specific mineral contents. Tansy plants must be structurally and functionally adapted to soil contents and enviromnental conditions. Concentrations of macro- and microelements in Tansy plants were a reflection of their concentration in soil. Also, plants from anthropogenic Ada Huja zone adapted on poor soil with a lot of sand and high concentrations of Ca, Fe, Si and Al.

Thus, the concentrations of macro- and microelements in anthropogenic and non-anthropogenic soils were not unfavourable for Tansy plants. Tansy showed a high degree of adaptability to adverse environmental conditions.

DISCUSSION

This paper investigates the concentration of macro- and microelements in soils, as well as in Tansy plants, and growth on anthropogenic and non anthropogenic site localities. The macro- and microelement contents depend mainly on the type of plant, environment (the level of industrial development of the region, air pollution and soil and climate conditions), in which the plant is grown (Voutsa et al., 1996; Ngole and Ekosse, 2009).

Macro- and micro- elements released from anthropogenic sources have entered the environment and have followed normal biogeochemical cycles (Jackson et al., 2003). At the time when environmental quality and food production are of major concern to man, a better understanding of the behavior of these elements in the soil-plant system seems to be particularly significant. The main sources of macro- and microelements to plants are their growth media (soil, air, and nutritient solutions) from which minerals are taken up by root or the foliage (Voutsa et al., 1996). Plants growing in a polluted environment can accumulate macro- and micro- elements at high concentrations, causing a serious risk to human health when plant based foodstuffs are consumed (Kabata-Pendis and Pendis, 1984; Hovmand et al., 1983; Pais, 1997). Macro- and microelements uptake by roots depends on both soil and plant factors (source and chemical form of elements in soil, pH, organic matter, plant species, plant age, etc). Element mobilility and plant availability are very important when assessing the effect of soil contamination on plant minerals uptake and related phytotoxic effects (Mench et al., 1994). Interaction between minerals occuring at the root surface and within the plant can affect uptake, as well as translocation and toxicity (Luo and Rimmer, 1995; Ande and Onajobi, 2009).).

Adequate pH is necessary to assure that soil minerals are "plant available". Plants generally cannot take up the minerals they need, when soil pH is at extremes.

Higher concentrations of Ca, Si and Al in investigated soil are in agreement with higher pH value in soil samples which is possibly found in similar locations (Kato et al., 1997). However, greater amount of S and P in soil on Topcider location is caused by better organic quality of humus soil on this site. The largest Ca, Fe, Si, and Al levels in soil samples from the Adam Huja was measured. Higher values of these minerals in Ada Huja soil due to this site location is dump garbage and building materials. The results of this experiment are in agreement with the expected results. The nutritional and chemical value of Tansy plants were investigated as well as of palm (Ezieshi and Olomu, 2007), and *Amaranthus hybridus (*Akubugwo et al., 2007) using standard analytical methods.

Table 2. Content of macro- and microelements in shoot and root of Tansy from Ada Huja and Topcider site locations.

Element	Content (%)				
	Ada Huja		Topčider		Range
	Shoot	Root	Shoot	Root	
S	0.11	0.20	0.22	0.40	0.1 - 0.5
P	0.11	0.06	0.78	0.39	0.1 - 0.8
K	4.43	2.25	4.40	2.21	1.0 - 6.0
Ca	1.70	3.33	0.90	2.00	0.3 - 3.0
Mg	0.20	0.11	1.00	0.58	0.1 - 1.0
Na	0.01	0.02	0.01	0.02	0.01 - 2.0
Fe	0.02	0.05	0.01	0.02	0.005 - 0.10
Si	0.58	1.00	0.38	0.80	0.2 - 0.80
Al	0.20	0.40	0.10	0.20	0.0001 - 0.30
Mn	0.015	0.007	0.02	0.01	0.005 - 0.025

Each data is mean of three replicates.

Sulfur was the most important element in Tansy plants originating from anthropogenic and non-anthropogenic localities. The concentration of Ca in Tansy from Ada Huja is greater than in plants from Topcider. Calcium deficiency or excess may completely stop the growth and plants may die (Singh and Singh, 2003). Similar results have been reported by Kumar et al. (1999), Rajakumar and Narayanaswamy (2004) .

Low quantity of Na and high level of K in Tansy from both site localities are necessary for good plant quality and excellent diuretic properties (Thangavelu et al., 2003). Amount of Mg in soil and Tansy from Topcider was very high. *T. vulgare* is one of the rare plant species which survive on this environmental conditions.

Kumar et al. (1999) and Rao (2000) showed that high Mg level gives plants a better taste, color and smell. It is of very great importance for Tansy plants from non anthropogenic Topcider site and these are used in medicine and nutrition. Magnesium acts as cofactor in sugar synthesis when it is available in greater amount in the metabolic environment (Rajakumar and Narayanaswamy, 2004).

The high concentration of iron in Tansy plants from anthropogenic Ada Huja site enables easier survival. Tansy is often present around the roads, dump, civil engeneering sities, even on the heavy contaminated habitats. Fe amount in Tansy plants, measured and presented in this paper are in correlation with results by Kumar et al. (1999) and Rajakumar and Narayanaswamy (2004). Iron is essential for chlorophyll and protein formation, photosynthesis, electron transfer, oxidation and reduction of nitrates and sulphates and other enzyme activities (Mohamed, 1999). Deficiency of iron causes interveinal chlorosis in newly emerging young leaves due to reduced chlorophyll synthesis, resulting in poor growth as well as loss in yield and sucrose content (Singh et al., 1992; Pais, 1997; Singh et al., 2000).

Mg content in Tansy plants from Topcider was high and this is in close agreement with the results obtained by Kulikova et al. (2005). High manganese status for availability combined with high organic matter is observed to improve soil quality (Kulikova et al., 2005). Also, distribution of the macro- and microelements among plant organs (shoot and root) depends on mobility of examined minerals. P, K, Mg and Mn are mobile elements, therefore thier levels were more in the Tansy leaves. However, amounts of S, Ca, Na Fe, Si and Al were higher in Tansy roots, simply because these minerals were immobile. Results about mobility of macro- and microelements in Tansy are in accordance with results on agricultural plants (Vukadinovic and Loncaric, 1997).

An ecological aspect of the role of macro- and microelements as well as essential oils is reflected in the interaction of plants with environmental factor. A variety of stressful conditions (unfavourable geological, pedological, climatic, or biotic conditions) increased the number of plants rich in essential oils and poor in macro- and micro elements.

The Tansy plant like cane plant (Kumar et al., 1999) takes up its need of trace elements from the surrounding soil. Tansy plants' survival in the urban conditions are by finding ways of adapting to environmental conditions.

Conclusion

The quantitative analysis shows the presence of varying amounts of S, P, K, Ca, Mg, Na, Fe, Si, Al and Mn in Tansy growing on anthropogenic and non anthropogenic localities. Macro- and microelements are present in the soil and Tansy medicinal plant at different concentrations, which depend on pollution degree.

Moreover, high concentration of Ca, Fe, Si and Al in Ada Huja soil is closely related with the influence of anthropogenic factors. *T. vulgare* grown on non anthropogenic Topcider site had a high nutritional value than plants from anthropogenic Ada Huja location.

The results obtained and presented in this paper show extreme sustainability and usefulness of Tansy plants, in spite of negative anthropogenic environmental conditions. Further studies on macro- and micro elements contents in wide spreader plants grown in Serbia environment are recommended.

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