The content of heavy metals in tissue of C*eratophyllum demersum* L. from Danube-Tisza-Danube canal in Banat region of Vojvodina (Serbia and Montenegro)

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Keywords: *Ceratophyllum demersum*, heavy metals, bioindication

Introduction

Heavy metals are presented in plants in small quantities (as elements which are merely present), but they have very important functions for plants. The concentration of pollutants in an aquatic environment relies primarily upon both the chemical composition of sediment and upon kind and amount of absorbed pollutants. Aquatic macrophytes may accumulate great amounts of chemicals, contributing to a nutrient cycling, water quality control, and sediment stability (CHAMBERS & PREPAS, 1994). Vascular aquatic may accumulate considerable amounts of heavy metals in their tissues (10-10^6 times those in nearby water environment) (KOVÀCS ET AL., 1984, ST-CYR ET AL., 1994). The problem of chemical contamination of Danube-Tisza-Danube (DTD) canal complex was accompanied by hypereutrophication, overgrowing and inundation. These detrimental changes are mainly due to irrigation of surrounding land brought into cultivation, widespread fishing and recreation. Therefore, a continuous monitoring of the ecological characteristics of the canal is needed to achieve sustainable development of this valuable natural resource (PAJEVIĆ ET AL., 2003). The aim of the present survey was to assess the ecological status, namely, the level of the chemical contamination of aquatic environment based on the determination of the heavy metal content in tissue of *Ceratophyllum demersum* species.

Materials and methods

Sampling of plants (*Ceratophyllum demersum*) was performed using a randomised block system at 12 sites of the DTD canal (Banat region of Vojvodina) during the summer at maximum development stage and the peak seasona biomass (June-August) of 2003 and 2004. For a more accurate comparability of results, the Ceratophyllum demersum were sampled from different sites wherever it was possible. Plant material in the laboratory is classified, parts of detritus and periphyton are removed and then washed out. After final rinsing in distilled water, the plant material was dried and prepared for analysis according to the standard methods for examination of water and wastewater of the American Public Health Association (FRANSON, 1995). After dry ashing at 450^0 C and treatment with HCl, concentrations heavy metals were determined by atomic absorption spectrophotometry (AAS) in the Faculty of technology, University of Novi Sad (Serbia). All analysis has been done in three independent repetitions for each sample, and the results have been analyzed by ANOVA method. Treatment comparison (species, locality) has been performed by Duncan test (multiple test of intervals), for level of significance $p<0.05$. Values for each treatment that are marked with same letter in the tables do not differ significantly for the mentioned level of importance.

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Results and discussion

Concentrations of lead (Pb) accumulated by species *Ceratophyllum demersum* in Banat region at several localities are greater than 10 μg/g, i. E. bigger than critical level of toxicity in plant tissue (KASTORI, 1997) (table 1 and 2). Concentration of lead in plants was 23,0 μg/g in Vlajkovac, to concentration 3,0 μg/g in Banatska Palanka (Table 2). Extremely high concentrations are also present in other localities in Banat, such as Jermenovci (11,2 μg/g) (table 2), Lazarevo (9,4 μg/g) (table 1). Concentration in Vlajkovac is even six times higher than concentration registered in tissue of this species in localities near Vroclav (Poland) (SAMECKA-CYMERMAN & KEMPERS, 1996).

Table 1. Concentration of heavy metals in tissue of *C. demersum* (Research during 2003)

Locality	Pb	Cd	Cu	Mn	Ni
	μg /g dry matter				
Zlatica	3,8 [c]	0,3 [d]	8,5 [f]	2558,7 [e]	14,3 [c]
Novo Miloševo	7,3 [b]	0,7 [c]	20,8 [b]	12561,0 [a]	23,4 [a]
Banatska Topola	5,6 [b]	0,3 [d]	9,4 [f]	1185,3 [fg]	6,2 [f]
Melenci	6,4 [b]	2,0 [b]	17,1 [d]	8607,0 [b]	23,9 [a]
Hetin	7,0 [b]	0,3 [d]	18,8 [c]	961,0 [g]	9,0 [e]
Jankov most	5,8 [b]	0,3 [d]	7,8 [f]	1340,7 [f]	10,8 [d]
Klek	5,9 [b]	2,7 [a]	15,1 [e]	6569,7 [d]	17,4 [b]
Lazarevo	9,4 [a]	2,4 [a]	23,4 [a]	6985,3 [c]	22,8 [a]
Average	**6,4**	**1,1**	**15,1**	**5096,1**	**16,0**

This concentration of lead shows a significant degree of mud (substratum), because concentration of lead above10 μg/g in plant tissue is considered to be an indicator of chemical contamination (KASTORI, 1997). Concentration of cadmium (Cd) is higher in Banat - to 2,7 μg/g in Klek locality, and just after it is Lazarevo with concentration 2,4 μg/g (table 1). The lowest concentration of cadmium is in locality of Banatska Palanka (0,2 μg/g) (table 2).

Table 2. Concentration of heavy metals in tissue of *C. demersum* (Research during 2004)

Locality	Pb	Cd	Cu	Fe	Co	Ni
	μg /g dry matter					
Jermenovci	11,2 [b]	0,4 [c]	15,4 [b]	7189,7 [c]	6,5 [b]	24,7 [ab]

Vračev Gaj	5,8 [c]	0,5 [b]	20,3 [a]	15460,0 [a]	7,4 [a]	21,2 [bc]
Vlajkovac	23,0 [a]	0,7 [a]	19,6 [a]	10945,6 [b]	7,0 [ab]	28,6 [a]
Banatska Palanka	3,0 [c]	0,2 [d]	9,3 [c]	5421,1 [c]	2,7 [c]	17,4 [c]
Average	**10,8**	**0,4**	**16,2**	**9754,1**	**5,9**	**23,0**

Comparing concentrations of lead and cadmium in tissue of *Ceratophyllum demersum* from locality Melenci (which is located on canal Banatska Palanka - Novi Bečej after flowing of Kikinda canal and before flowing of Stari and Plovni Begej) and locality Lazarevo (downstream from Melenci, after flowing of Stari and Plovni Begej), it could be concluded that there is increased chemical contamination of water flow of the Canal, because there have been noticed higher concentrations of mentioned pollutants in plant samples from Lazarevo. Copper (Cu), also, appears in higher concentrations in tissue of this species in Banat localities. High concentrations of copper are in Lazarevo (23,4 μg/g) (table 1), and also in two localities where concentrations are not statistical significant, Vračev Gaj (20,3 μg/g) and Vlajkovac (19,6 μg/g) (table 2). The highest concentrations of iron (Fe) are on localities Vračev Gaj (15460,0 μg/g) and Vlajkovac (10945,6 μg/g) (table 2). Banat is region which is presented with important concentration of this metal. Concentration of manganese (Mn) in tissue of this species has been considerable high in Banat. Registered concentrations of manganese were from 12561,0 μg/g in locality Novo Miloševo and 6985,3 μg/g (locality Lazarevo) and to much lower in locality Hetin (961,0 μg/g) (table 1). The highest concentrations of cobalt (Co) are registered in locality Vračev Gaj (7,4 μg/g). The lowest concentration of cobalt was on locality Banatska Palanka (2,7 μg/g) (table 2). In locality Vlajkovac was conspicous concentration of nickel (Ni) - 28,6 μg/g in plant tissue (table 2). The lowest concentration of nickel is registered in locality Banatska Topola (6,2 μg/g) (table 1). When concentrations of metals in tissue of species *Ceratophyllum demersum* are compared to the results from the same locality during the research in 2000 (June-August), it is evident that contamination of this area is increased (PAJEVIĆ ET AL., 2001). The reason for this is flow of contaminated water from cities and increased amount of waste water from Romania, Plovni Begej river. High concentrations of heavy metals in plant tissues indicates a chemical load of canal water of this region which is due to the industrial wastewaters and wastewaters from municipal and rural localities along the canal stream.

Summary

Monitoring of the aquatic environment by chemical analyses of dominant aquatic macrophytes from DTD canal indicating possible chemical contamination of water and littoral zone was surveyed. Twelve sampling sites from the canal reach in the Banat region of Vojvodina province were selected to assess the effect of anthropogenic activities upon the quality of the canal water and therefore upon plant world. Samples of the dominant aquatic plant species *C. demersum* were collected at plant maximum development stage in two years. Concentrations of Mn, Ni, Cu, Pb and Cd in the plant tissue were determined by standard methods using AAS. Although, variations of metal concentrations as related to year of research were found, it can be concluded that very high accumulation of heavy metals were detected in plant tissue. Significant variation of heavy metals content in plant tissue depennding of the locality was also observed. Significant concentration of Mn in *C. demersum* in Novo Miloševo locality (1.25%) was detected. This indicate an increase in chemical pollution of the canal water near Kikinda city. The highest accumulation of Pb was

detected in the Vlajkovac locality (23,0 μg/g). Localities Srpski Itebej and Klek were also loaded with heavy metals. Our investigation may contribute to the protection of areas undergoing strong impact due to human activities. The obtained results should also point out the role of macrophytic vegetation in pollutant (heavy metals and nutrients) phytoremediation.

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