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EVALUATION OF CAPACITY FOR BIOACCUMULATION OF SOME HEAVY METALS IN THREE AQUATIC PLANTS SPECIES

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Abstract

This work is about evaluation of capacity for some heavy metals uptake and bioaccumulation factor at *Polytrichum commune*, *Elodea canadensis* and *Spirogyra* sp. harvested from Tisa rivulet valey, County Dambovita. Were determinated the concentrations of chromium, lead, strontium, copper, zinc, cobalt, manganese and iron from plants and substrate (mud) by EDXRF (spectrometry of fluorescence) method. For example chromium concentration in *Polytrichum commune* was 2040 ppm, comparatively to 2990 ppm in *Elodea canadensis*. Also was calculated the bioabsorption factor for each case. Bioabsorption factor value was very higher for cobalt (1239%) at moss species, for lead (1613%) at *Elodea canadensis* and for iron (1025%) at *Spirogyra sp.*

Keywords: bioaccumulation factor, heavy metals, aquatic plants.

INTRODUCTION

A lot of studies are today developing about the content of heavy metals in plants [8, 10, 12]. In this way, aquatic plants are very interesting because of their double possibilities for accumulating metals from substrate and water as well. So, it is very hard to establish what is the source of metal species for plants, in aquatic ecosystem. The studies now are focused on pollution biomonitoring of water quality by using plant species as bioindicators, such as *Polytrichum commune*, *Elodea canadensis* and/or *Spyrogyra*. These species belog to different systematic group, but every one has a characteristic potential for bioabsorption and bioaccumulation heavy metals. For example K. C. Jones and col. in 1985 [9] found Cd, Cu, Pb and Zn in *Polytrichum commune* growing in surface water from mining district of Midwales, Great Britain. In 2003 Bern Markert and Vera Weckert affirmed that *Polytrichum commune* is a passive biomonitor for cadmium, copper, lead and zinc [3, 4]. Roger A. Mayes and Alan W. McIntosh in 1977 determinated two metals, Cd and Pb in *Elodea canadensis* and established the influence of substrate content on level concentration in plant. Others (Mika A. Kahkonen and col. in 1998) found Fe, Mn, Cu, Zn, Ni and Cr in *Elodea canadensis* in different concentrations [11]. Nord L. and col. in 1973 [5] studiyng some algae species sampled from Missouri river found lead, zinc, copper and manganese in *Spirogyra*, too. In 2006 some authors (V. K. Gupta and col., 2001 and 2006) studied the bioabsorption capacity of *Spirogyra* for Cu (II) [6, 7]. In 2007 onother group of authors (E. Romera and col.) go to study the content of Cd, Ni, Zn, Co and Pb in some algae species as *Spirogyra insignis*, and found significant concentration [12].

MATERIAL AND METHOD

It was sampled mud and plants from three places along Tisa rivulet on zone of Dambovita County, from lentic ecosystem. Plant samples consist in *Spirogyra sp*., *Elodea canadensis* and *Polytrichum commune*. From each place were sampled the three species of plant and mud.

The samples were weighted first and than dried at 60°C for some hours. After drying operation the samples were weighted again. The method for analyzing was chosen carefully and not at random. The analyses were made by spectrometry of fluorescence (EDXRF) because this method is not destructive one and on can use the same samples to be analyzed by others methods [1, 14, 15]. The elemental content of biological and environmental samples was determined using Elva-X spectrometer having a X-ray tube with Rh anode at ICSMT (Research Institute) of Valahia University of Targoviste.The samples were excited for 300s and the characteristic X-rays were detected by a multichannel spectrometer based on a solid state Si-pin diode X-ray detector with a 140 mm Be window and a energy resolution of 200eV at 5.9 KeV 91,20 (2,19). Elva-X software was used to interpret the EDXRF spectra. The accuracy and precision of results were evaluated by measuring a certified reference sample (NISTSRM 1571- Orchard biological samples) [2]. By this method were obtained the concentration level of chromium, copper, strontium, lead, zincum, cobalt, manganese, iron, titanium and arsenium. The sensitivity of method is 1ppm.

Every result presented reprezents the average of some determinations (at least three).

Bioaccumulation factor was calculated after the following mathematics equation:

$$Bf\% = \frac{C_p \times 100}{C_s}$$

Were: *Bf%* = level of metal concentration;
Cp = metal content in plant;
Cs = metal content in substrate (mud in this case).

RESULTS AND DISCUSSIONS

In figure 1 on can see that iron was in high concentration both in moss and mud, with a little difference from one sample to other. Mn, Co and Zn were determinate in very low concentration, but with difference from a metal to another in moss and mud. Only in case of manganese *Politrychum commune* accumulated much more than the concentration existed in mud. For all others metals the concentrations were found under that of mud content as value.

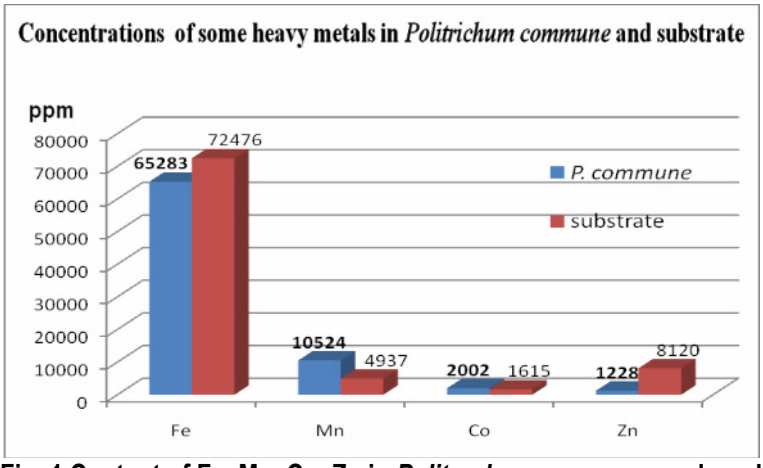

Fig. 1 Content of Fe, Mn, Co, Zn in *Politrychum commune* and mud

The content of copper, lead and strontium was higher generally and over the level of mud concentrations (figure 2). The highest values were obtained in case of copper. Arsenium and titanium were in very low trace in moss comparatively with mud content.

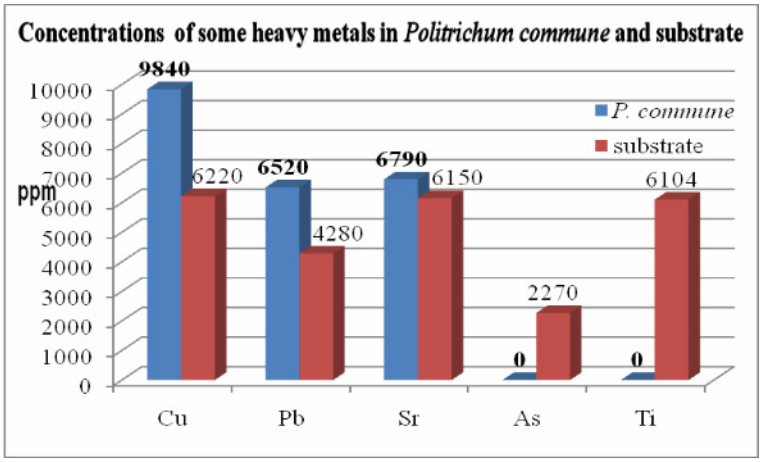

Fig. 2 Content of Cu, Pb, Sr, As and Ti in *Politrychum commune* and mud

The highest content find in *Elodea canadensis* was for iron and the lowest one was obtained for arsenium and titanium which were in trace (figure 3). Iron, copper, strontium and lead were accumulated in quantities higher than that contained in mud. A cobalt and manganese quantity in plant was lower than of mud content.

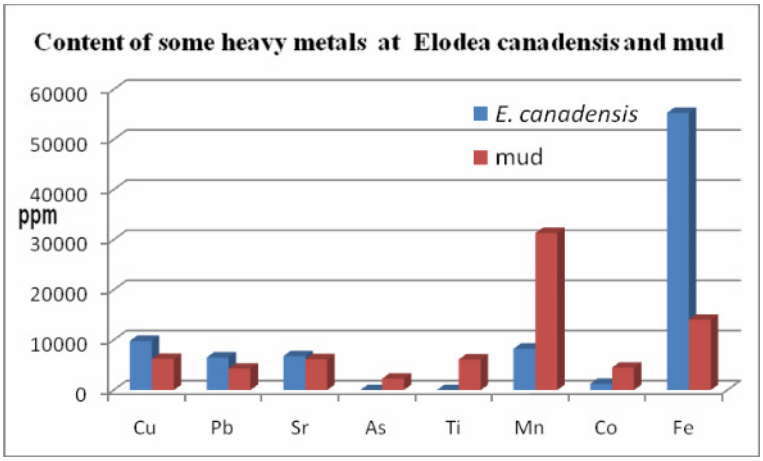

Fig. 3 Content of Cu, Pb, Sr, As, Ti, Mn, Co, and Fe in *Elodeea cannadensis* and mud

In *Spirogyra sp*. were find manganese and iron in important quantities, but a little under these obtained in case of mud (figure 4). Manganese was in highest concentrations. The others metals species as cobalt, zinc, copper and chromium were in lower concentrations in algae and mud, and lead and arsenium were detected in trace.

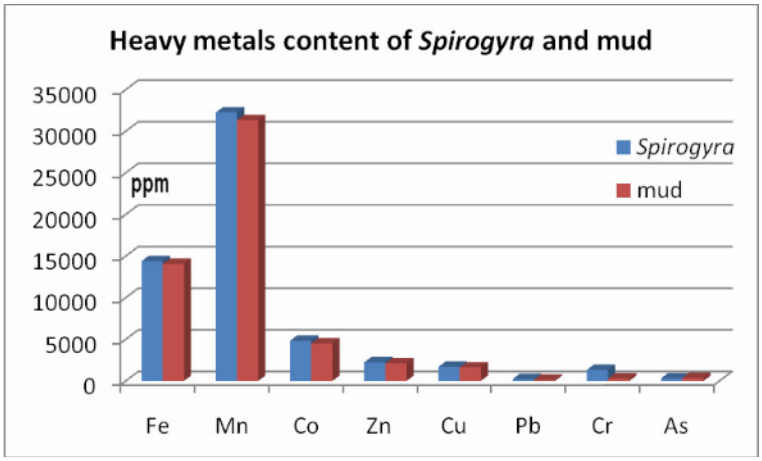

Fig. 4 Content of Fe, Mn, Zn, Cu, Pb, Cr, and As in *Spirogyra sp.* and mud

Bioaccumulation factor calculated for each case and each metal shows a highest affinity of *Politrychum commune* for accumulating cobat (1239%), of *Elodea canadensis* for accumulating lead (1613%) and *Spirogyra sp.* for accumulating iron (1025%) (Table 1). A good accumulation had *Politrychum commune* for manganese (213%), copper (158%), lead (153%) and strontium (110%).

Elodea cannadensis had a good accumulation of iron (393%), zinc (369%), cobalt (276%) and copper (219%) (Table 1).

Spyrogira sp. had a bioaccumulation factor between 103% and 153% increasing from manganese, copper, zinc, cobalt to lead (Table 1).

Spyrogira sp. cannot accumulate strontium; *Politrychum commune* cannot uptake arsenium; *Elodea canadensis* connot uptake strontium and arsenium.

Table 1. Values of Bioaccumulation factor of studied metals

Nr. crt.	Plant species	Bf% of metal species							
		Fe	Mn	Cu	Zn	Co	Pb	Sr	As
1	*Poltrychum commune*	90	213	158	151	**1239**	153	110	4
2	*Elodea canadensis*	393	26	219	369	276	**1613**	2	3
3	*Spirogyra sp.*	**1025**	103	104	105	107	153	2	86

CONCLUSIONS

- ✓ *Politrychum commune* and *Elodea canadensis* accumulated iron in highest quantities.
- ✓ *Spyrogira sp*. concentrated manganese in highest quantities.
- ✓ The highest values for bioaccumulation factor were obtained in case of *Politrychum commune* for Co, at *Elodea canadensis* for Pb and *Spyrogira sp*. for Fe.
- ✓ Concerning bioaccumulation factor for copper and zinc it was significant studied species.
- ✓ *Elodea canadensis* had not affinity for absorbing manganese, strontium and arsenium.
- ✓ All plants species studied can be used in monitoring process of aquatic ecosystem quality concerning heavy metals pollution.

REFERENCES

1. Arai, T., 2004, Analytical precision and accuracy in X-ray fluorescence analysis, Rigaku J., 21:26-38.
2. ASTM Standard D6247-(1998), Standard Test Method for Analysis of Elemental Content
In Polyolefins by X-Ray Fluorescence spectrometry, ASTM International, West Conshohocken.
3. Bernd Markert, Vera Weckert, 2003, Use of *Polytrichum formosum* (moss) as a passive biomonitor for heavymetal pollution (cadmium, copper, lead and zinc), Science of The Total Environment, Volume 86, Issue 3, Pages 289–294.
4. Bernd Markert, Vera Weckert, 2003, Higher lead concentrations in the environment of former West Germany after the fall of the 'Berlin Wall', Science of The Total Environment Volume 158, Pages 93–96.
5. Gale Nord L., Wixson Bobby G., Hardie Michael G., J. Jenne Charles, 1973, Aquatic organisms and heavy metals in Missouri's new lead belt, JAWRA Journal of the American Water Resources Association, Volume 9, Issue 4, pages 673–688, August 1973.
6. Gupta V.K., Shrivastava A.K., Neeraj Jain, 2001, Biosorption of chromium(VI) from aqueous solutions by green algae *Spirogyra* species Water Research Volume 35, Issue 17, Pages 4079–4085.
7. Gupta V.K., Rastogi Arshi, Saini V.K., Neeraj Jain, 2006, Biosorption of copper(II) from aqueous solutions by *Spirogyra* species. Journal of Colloid and Interface Science, Volume 296, Issue 1, Pages 59–63.
8. Herpin U., Berlekamp J. Markert B., Wolterbeek B., K. Grodzinska, U. Siewers, H. Lieth, V. Weckert, 1999, The distribution of heavy metals in a transect of the three states the Netherlands, Germany and Poland, determined with the aid of moss monitoring Science of The Total Environment Volume 187, Issue 3, 1996, Pages 185–198.
9. Jones K. C., Peterson P. J. , Davies B. E., 1985, Silver and other metals in some aquatic bryophytes from streams in the lead mining district of Mid-Wales, Great Britainm, Water, Air, & Soil Pollution , Volume 24, Number 3.
10. Kähkönen Mika A. , Mari Pantsar-Kallio, Pentti K.G. Manninen, 1998, Analysing heavymetal concentrations in the different parts of *Elodea canadensis* and surface sediment with pca in two boreal lakes in southern finland, Chemosphere, Volume 35, Issue 11, Pages 2645–2656
11. Mayes Roger A., Alan W. McIntosh, 1977, Uptake of cadmium and lead by a rooted aquatic macrophyte (*Elodea canadensis*), Ecology 58, p. 1176-1180.
12. Romera E., González Ballester A., Blázquez M.L., Muñoz J.A., 2007, Comparative study of biosorption of heavy metals using different types of algae, Bioresource Technology, Volume 98, Issue 17, Pages 3344–3353.
13. Shakya K, Chettri MK, Sawidis T., 2008, Impact of heavy metals (copper, zinc, and lead) on the chlorophyll content of some mosses, Arch Environ Contam Toxicol. 54(3):412-21.
14. Steinnes, E., Johansen, O., Royset, O., Odegard, M., 1993, Comparison of different multi-element techniques for analysis of mosses used as biomonitors. Environmental Monitoring and Assessment, 25, 2, p.87-97.
15. Winefordner, J.D., 1999, Chemical analysis. X-ray Fluorescence Spectrometry. JOHN Wiley and Sons, INC. USA.