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The Uptake of Nickel and Copper from water by *Apium nodifolium* (L.) Lag.

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Heavy metal pollution is a major environmental problem the modern world. The most commonly used methods for dealing with heavy metal pollution are still extremely costly. These methods have different efficiencies for different metals and may be very costly if large volumes, low metal concentrations, and high cleanup standards are involved. The use of metal- accumulating plants to clean soil and water contaminated with toxic metals is the most rapidly developing component of this environment friendly and cost-effective technology. The removal of Cu (highest BCF= 1614) and Ni (1116) from water was studied using different Ni and Cu exposure levels in laboratory by macrophyte, *Apium nodifolium* (L.) Lag. The uptake rate of Cu and Ni increased, when the exposure time came longer and the initial concentration was lower.

Key words: Uptake, Macrophyte, Apium nodifolium, Nickel, Copper.

Heavy metals are major environmental pollutants and many of them are toxic even at very low concentrations (Memon et al. 2001). Heavy metal contamination can be separated from aquatic wetland using a variety of technologies, including chemical and biological (Axtell et al. 2003). Aquatic plants are known to remove metals from their environment and this is well documented (Soltanand et al. 2003; Gupta et al. 2006). The growth rate and yield of hyacinths are important factors in evaluating these plants for removal of metal ions, especially for the needs of people of developing countries. Moreover aquatic plant is also being used for production of materials such as paper, roofing and a variety of chemicals (Srivastav et al. 1994; Jain et al. 1990).

Nickel and copper metals are reported in natural and wastewater. Although nickel does not have any metabolic use for plants, it has several industrial applications, viz. electroplating, pigments, stabilizers, batteries alloy etc. However, Cu is essential for plant metabolism and also had a number of industrial practices (Kaçar' 1972). Ni has been recognized for its harmful effect on the environment where it accumulates throughout the food chain posing a serious threat to human living health. Copper has been shown to be one of the most toxic heavy metals to human and animals when it was excess concentration in water. The aim of study is to assess the ability of *Apium nodifolium* to take up the heavy metals Ni, Cu from the water at various nickel and chromium exposure level.

MATERIALS AND METHODS

Plant Material

Apium nodifolium is a species of the family *Apiaceae* (Umbelliferae family). *Apium nodiflorum*, extensively called Fool's-water-cress is a flowering plant found in ditches or streams and native to Western Europe. They occur in a variety of aquatic habitats. *Apium nodifolium* was collected from Işıklı lake Figure (1), Denizli City Turkey in 2013 and were transferred the laboratory in polyethylene bags. All the chemicals used were of Analar grade (Merck). Working metal and standard solutions with different concentrations (1.0, 3.0, 5.0 and 7.0 ppm) of each element were prepared by diluting the

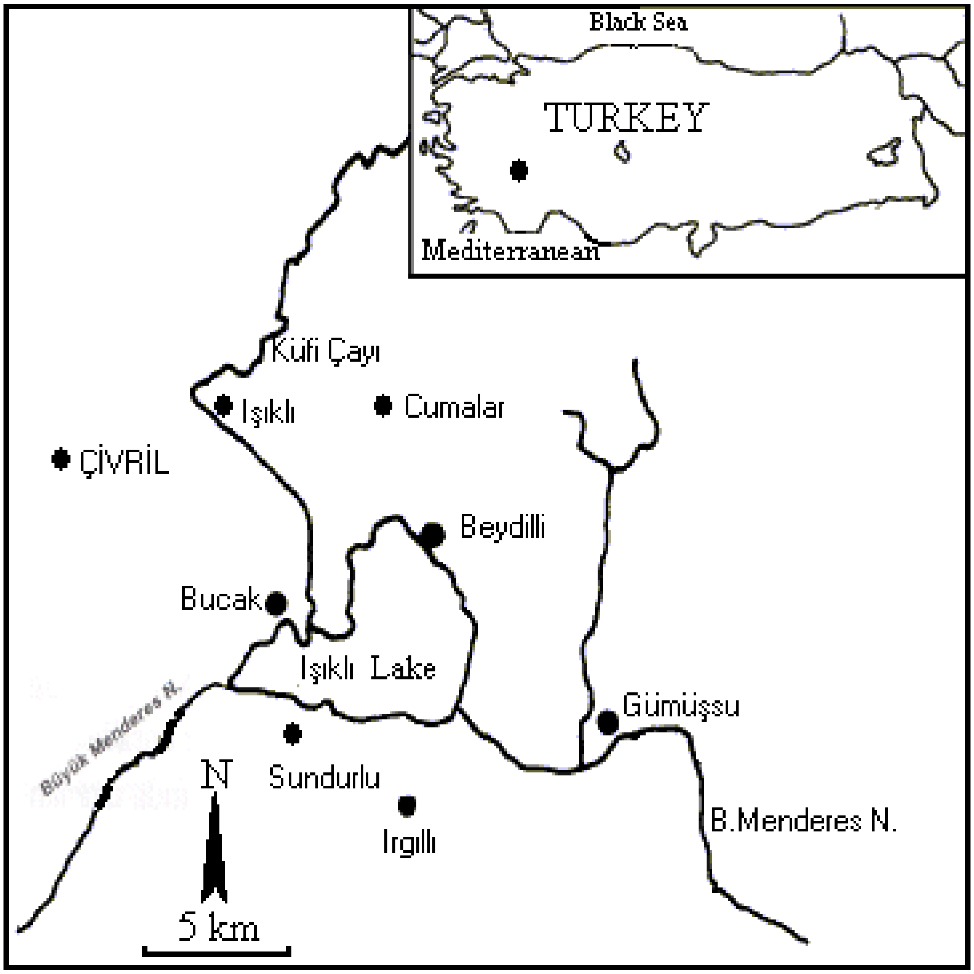

Figure1. Map of study area

stock solution (1000 ppm) using deionized water.

Digestion of plant samples in this study was performed as described by Kaçar (1972). After the termination of each experiment, the plants were washed well using tap water and distilled water. The washed samples were carefully dried of adherent water using absorbent paper. Samples were dried to a constant mass in a fan-forced oven at 80 ºC (overnight). The oven-dried material was chopped finally then ground to ensure homogeneity and to facilitate organic matter digestion. Approximately 1.0 g of ground material from each sample was accurately weighed into 150 ml erlenmeyer flasks. Concentrated nitric acid (5 ml) was added to each flask and the samples were placed on a water batch. The temperature of water batch was set at 40 °C and the samples were holding on a water batch (about 1 h.). Then the samples were heated on a heating block until the nitric acid solutions completely evaporate. Then the samples were cooled, 10 ml of concentrated $HNO_3/H_2SO_4/HClO_4$ acid mixture (10:1: 4 v/v) was added and the mixture was heated again at 150 ºC. Digestion was continued until the solution became clear. Then the samples were cooled again. The solutions were filtered and made up to 100 ml with deionized water.

Analysis of samples

Metal contents of the plant samples were determined using an Atomic Absorption Spectrophotometer (AAS 700, Perkin Elmer). The values of the metal content were calculated in µg g-1 dry wt.

Table 1. The removal rates of heavy metals by *Apium nodiflorum*

Time (Day)	Metal Concentration (mg/ l)	*Apium nodiflorum*(µg/g) ± SE	
		(Ni)	*(Cu)*
1	Control	56.0 ± 13.44	19.0 ± 4.24
	1	143 ± 4.24	123 ± 0.71
	3	255 ±9.90	258 ± 0.71
	5	359 ± 7.09	315 ± 1.41
	7	452 ± 5.66	623 ± 5.66
2	1	300 ± 6.36	285 ± 1.41
	3	469 ± 2.83	493 ± 4.95
	5	517 ± 5.66	637 ± 6.36
	7	724 ± 8.49	1004 ± 2.12
3	1	336 ± 5.66	300 ± 2.12
	3	667 ± 4.24	677 ± 7.78
	5	696 ± 4.24	764 ± 7.07
	7	1105 ± 2.83	1355 ± 1.41
4	1	587 ± 2.12	548 ± 5.66
	3	1071 ± 1.41	869 ± 3.54
	5	1083 ± 0.71	1207 ± 4.24
	7	1116 ± 4.95	1614 ± 0.71

Table 2. Bioconcentration factors (BCF) for Ni and Cu in various plants

Plant Species	BCF (µg/g)		References
	Ni	Cu	
Apium nodiflorium	587	548	Present study
Lemna minor	5500	647	Dirilgen and Inel 1994
Eichornia crassipes	10,7	11,5	Zhu et al., 1999
Ceratophyllum demersum	18,5	5,3	Stankovic et al., 2000
Juncus bulbosus	23	47	Cymerman and Kempers, 2001
Azolla filiculoides	20339	43779	Sela et al., 1989

$$\mathrm{BCF} = \frac{\text{Trace element concentation in plant tissue} (\mu g\ g^{-1}) \text{ at harvest}}{\text{Initial concentration of the element in the external nutrient solution} (mg/L)}$$

The bioconcentration factor (BCF) provides an index of the ability of the plant to accumulate the metal with respect to the metal concentration in the substrate. The BCF were calculated as described by Zayed (1998) based on the initial concentration of the given element in the culture medium.

Statistical Methods

All experiments were carried out in duplicate and the results were analyzed using the Minitab statistics package program 13.0.

RESULTS AND DISCUSSION

The removal rates of heavy metals by *A. nodiflorum* are listed in (Table 1). These data are indicative of two important findings. First; the uptake of heavy metals by *A. nodiflorum* generally increased with increasing metal concentrations and changing time ($p<0.05$). Second; Ni less accumulates than Cu by *A. nodiflorum.* A good heavy metal accumulator should have BCF of more than 1000 (a 100 fold compared on a fresh weight, or in vivo basis). BCF values of copper were higher when compared with that of cadmium in *A. nodiflorum*. The higher value of BCF indicates that *A. nodiflorum* is more effective for removal of copper. According to BCF values, the more accumulation has materialized in low concentrations and first day, then the accumulation has gradually decreased in following days. The maximum values of bioconcentration factor (BCF) for Ni and Cu were 136 and 1669 µg. Bioconcentration factors reported for Ni and Cu in several aquatic plants are presented in Table 2. The BCF values of copper were higher when compared with that of cadmium in *A. nodiflorum*. The higher value of BCF indicates that *A. nodiflorum* is more effective for removal of copper. The results showed that under experimental conditions, *A. nodiflorum* proved to be a good accumulator of Cd and Cu. Removal of metals from solution was fast in the four days. The accumulation of Cd and Cu increased with the initial concentration and also with the passage of time. The highest concentrations of each trace element accumulated in A. *nodiflorum* tissues were 1116 µg Ni g-1, 1614 µg Cu g-1 in after 4 days.

REFERENCES

Memon AR. Aktoprakligil D. Ozdemir A, 2001. Heavy metal accumulation and detoxification mechanisms in plants. Turk J. Bot. 25: 111-121.

Axtell NR. Sternberg SPK. Claussen K, 2003. Lead and nickel removal using Microspora and *Lemna minor*. Bio. Technolo. 89: 41-48.

Soltanand ME. Rashed MN, 2003. Laboratory study on the survival of water hyacinth under several conditions of heavy metal concentrations. Advances Environ. Res. 7: 321-324.

Gupta P and Chandra P, 1996. Response of cadmium to *Ceratophyllum demersum* L., a rootless submerged plant. Waste. Manage.16: (4), 335-337.

R.K. Srivastav, S.K. Gupta, K.D.P. Nigam and P. Vasudevan, 1994. Treatment of chromium and nickel in wastewater by using aquatic plants Wat.Res., 28, No:7, 1631-1638.

Jain SK, Vasusevan P and Jha NK, 1990. Azolla pinnata R.Br. and *Lemna minor* L. for removal of lead and zinc from polluted water. Wat.Res. 24:(2), 177-183.

Kaçar B, 1972. Ankara Ünv, Ziraat Fak. Yayınları: 453, Uygulama Klavuzu: 155, Ankara,.p:646.

Lu X, Kruatrachue M, Pokethitiyook P and Homyok K, 2004. Removal of cadmium and Zinc by Water Hyacinth *Eichhorrnia crassipes*. Sci. Asia. 30: 93-103.

Zayed A, Gowthaman S and Terry N, 1998. Phytoaccumulation of trace elements by wetland plants: I. Duckweed. J.of Enviro. Qual. 27: 339-344.

Dirilgen N, 1994. Effects of zinc and copper on growth and metal. Bull. Environ. Contam. Toxicol. 53: 442-449.

Stankovic Z, Pajevi S and Vuckovic M, 2000. Concentrations of trace metals in dominant. Biol. Plantarum. 43 (4): 583-585.

Zhu L, Zayed AM, Qian JH, Souza M and Terry N, 1999. Phytoaccumulation of trace elements by wetlands. J. Environ. Qual. 28: (1) 339-344.

Cymerman AS and Kempers AJ, 2001. Concentrations of heavy metals and plant nutrients in water, sediments and aquatic macrophtes of anthropogenic lakes. Differing in stage of acidification. Sci. Total Environ. 281: 87-98.

Sela M, Garty, EJ, 1989. The accumulation and the effect of heavy metals on the water fern *Azolla filiculoides*. New Phytol. 112: 7-12.