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Biosorption Method of Removal of Nickel(II) Accumulated with *Nasturtium officinale* in Water

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In present study, *Nasturtium officinale* has been used as a plant. The plant has been collected from the campus of Dicle University of Turkey. Air roots of the plant with the same number and morphology of leaf has been chosen. For biosorption of Ni^{2+} metal ions by *Nasturtium officinale* the solutions were prepared as 0.1, 0.3, 0.5, 1.0, 2.0, 3.0, 4.0 and 5.0 ppm, respectively. It was seen that plants with low Ni^{2+} concentration medium biosorped all heavy metals in medium with passage of time, plants started deforming from their roots. Though some plants grown at 4 ppm biosorped less than 5 ppm it was exceptional and couldn't be generalized.

Key Words: Biosorption, *Nasturtium officinale*, Ni(II), Accumulation.

INTRODUCTION

Nickel(II) used in industry causes various health and environmental problems by accumulating on live r tissue. To tackle with issue, many bacteria, algae and high plants are used. Heavy metals such as nickel have been biosorped by using various primitive and high plants[1-10]. Many plants and algae can accumulate high concentrations of metals such as nickel in their tissues. These plants called as hyperaccumulators have their capacity either to survive in environments with high metal concentrations or to employ the metals as a natural pesticide. Recently, several applications have been developed to put this phenomenon to use[11]. In bioremediation, metal accumulating organisms are used to remove metallic pollutants from soil or wastewater. By growing and harvesting of metal accumulating plants on a polluted soil, metal levels will drop below the legally required level. The removal of metallic pollutants from waste waters by algae has also been demonstrated[12,13].

The aim of this paper was to investigate concentrations of heavy metals in water and plants collected in wastewater affected by heavy metals pollution. In present studies, *Nasturtium officinale* was used as a biosorption plant to remove Ni^{2+} present in water.

EXPERIMENTAL

The changes in general appearance of plant after biosorption of Ni^{2+} metal with 0.1 and 0.3 ppm concentration by *Nasturtium officinale* (Table-1), the plant with 1.7 g wet weight has 0.03 ppm standard absorbance at 0.1 ppm concentration and its sample absorbance has been measured as 0.000 ppm. After 24 h, the amount of Ni^{2+} taken by plant is 5.88 µg/g. The amount of Ni^{2+} per hectare is 2632424 mg.

The plant with 1.8 g wet weight has 0.006 ppm standard absorbance at 0.03 ppm concentration and its sample absorbance has been measured as 0.000 ppm. After 24 h, the amount of Ni taken by plant 16.66 µg/g. The amount of Ni^{2+} per hectare as 7463680 mg. The amount of nickel has taken by the plant at optimum level.

The plant with 1.8 g wet weight has 0.010 ppm standard absorbance at 0.5 ppm concentration and its sample absorbance has been 0.000 ppm. After 24 h the amount of Ni^{2+} 27.77 µg/g. The amount of Ni^{2+} per hectare as mg is 1244096. However, Ni^{2+} ions from water by plant absorption operations completely.

The plant with 1.6 g wet weight has 0.018 ppm standard absorbance at 1.0 ppm concentration and its sample absorbance has been 0.006 ppm. After 24 h, the amount of Ni^{2+} 41.65 µg/g. The amount of Ni^{2+} per hectare18659200 mg.

The plant with 2 g wet weight has 0.037 ppm standard absorbance at 2 ppm concentration and its sample absorbance has been 0.017 ppm. After 24 h, the amount of Ni^{2+} 52.49 µg/g. The amount of Ni^{2+} per hectare 2351552 mg. A proportional sample of the nickel ions at the optimum level of water absorption operations by the plant.

The plant with 1.6 g wet weight has 0.056 ppm standard absorbance at 3 ppm concentration and its sample absorbance has been 0.025 ppm. After 24 h, the amount of Ni^{2+} 105.76

TABLE-1
QUANTITY OF Ni^{2+} BIOSORPED BY *Nasturtium officinale* WITH RESPECT TO WET WEIGHT AFTER 24, 48 AND 72 h

Wet weight (g)	Concentration (ppm)	Standard absorbance (ppm)	Sample absorbance (ppm)	Hour	Quantity of Ni^{2+} taken by plant (µg/g)	Per hectare (mg)
1.7	0.1	0.003	0.000	24	5.88	263424
1.8	0.3	0.006	0.000	24	16.66	7463680
1.8	0.5	0.010	0.000	24	27.77	1244096
1.6	1.0	0.018	0.006	24	41.65	1865920
2.1	2.0	0.037	0.017	24	52.49	2351552
1.6	3.0	0.056	0.025	24	105.76	4738048
1.5	4.0	0.076	0.070	24	25.65	1149120
1.6	5.0	0.100	0.095	24	6.43	288064
1.6	1.0	0.018	0.003	48	51.27	2296896
2.1	2.0	0.037	0.012	48	64.70	2898560
1.6	3.0	0.056	0.010	48	153.8	6890240
1.5	4.0	0.076	0.055	48	76.93	3446464
1.6	5.0	0.100	0.087	48	32.06	1436288
1.6	1.0	0.018	0.001	72	57.68	2584064
2.1	2.0	0.037	0.008	72	74.47	3336256
1.6	3.0	0.056	0.004	72	173.06	7753088
1.5	4.0	0.076	0.022	72	189.70	8498560
1.6	5.0	0.100	0.035	72	198.70	8901760

Note: In calculations of Ni^{2+} concentration (K=51.277, B=+0.0258).

µg/g. The amount of Ni^{2+} per hectare 4738048 mg. As can be seen from the Table-1, the sample size of the plant at this concentration is quite higher than its rate of absorption of the maximum level[9,10].

The plant with 1.5 g wet weight has 0.076 ppm standard absorbance at 4 ppm concentration and its samples absorbance has been 0.070 ppm. After 24 h, the amount of Ni^{2+} 25.65 µg/g. The amount of Ni^{2+} per hectare1149120 mg. Sample concentration, the amount of absorbed much more compared to the previous one has an obvious decrease.

The plant with 1.6 g wet weight has 0.100 standard absorbance at 5 ppm concentration and its samples absorbance has been 0.095 ppm. After 24 h, the amount of Ni^{2+} 6.43 µg/g. The amount of Ni^{2+} per hectare 288064 mg. Maximum sampling rate of this decline in concentration was observed in the extreme.

Evaluation of general morphological appearance of *Nasturtium officinale* in solution of Ni^{2+} with 0.1 ppm and 3.0 ppm after 24 h: The overall appearance of the plant withconcentration 0.1, 0.3 and 0.5 ppm for 24 h, waiting plants of since low concentration of though not detect an obvious abnormality 0.1 ppm in the normal development. Plant new root semering regions between nodes. Normal length and length of 24 h and 0.3 ppm. Old leaves have very little yellowing. Developing new aerial roots, 24 h and 0.5 ppm peak is developing buds. The roots have positive geotropism. At 0.1 ppm of the plant biosorption the amount of Ni^{2+} 5.88 µg/g. At 5.0 ppm this value for the same period was a found to be 6.43 µg/g. At 0.3 ppm (16.66 µg/g) and 0.5 ppm (27.77 µg/g), while in has been biosorption. However, at 1.0 ppm 41.65 µg/g, 2.0 ppm of the continued increasing an amount of 52.49 µg/g as a value although linear.A value of 3.0 ppm was taken as 105.76 µg/g. Meanwhile the normal state is manifest, means that the water plant at this concentration given metal ions in the amount and the downfall of this value of 4.0 ppm nickel is carcinogenic effect of excessive abnormal or plants due to physiological structure.

Quantity of Ni^{2+} biosorption of plants (*Nasturtium officinale*) grown in solution with different Ni^{+2} concentration and different weight: As shown in Table-1, the plant with 1.6 g wet weight has 1.0 ppm concentration and 0.018 ppm standard absorption and its samples absorbance has been calculated 0.003 ppm. The Ni^{2+} quantity of sample taken from 51.27 µg/g after 24 h. The quantity per hectare is 2296896 mg, gradually increased by 48 h.

The plant with 2.1 g wet weight has 0.037 ppm standard absorbance and 2.0 ppm concentration and its samples absorbancehas been calculated 0.012 ppm. The Ni^{2+} quantity of the sample taken from water is Ni^{2+} 64.70 µg/g after 48 h. The quantity of per hectare is 2898560 mg. Metal ions in plant biosorption here on a regular basis.

The plant with 1.5 wet weight has 0.076 standard absorbance at 4.0 ppm concentration and its samples absorbance has been measured as 0.055 ppm. After 48 h, the quantity of Ni^{2+} taken from the vicinity by the plant is 76.93 µg/g. The amount of per hectare is 3446464 mg. Here optimum absorption operations metal ions.

The plant with 1.6 wet weight has 0.100 ppm standard absorbance at 5.0 ppm concentration and its samples absorbance has been measured as 0.087 ppm. After 48 h, the amount of Ni^{2+} taken by plant 32.06 µg/g. The amount of per hectare is 1436288 mg.

General morphological view of *Nasturtium officinale* in 1.0 ppm Ni^{2+} and 3.0 ppm Ni^{2+}solutions after 48 h: 0.1, 0.3 and 0.5 ppm in all 24 h of ppm of 1.0-5.0, here we interpreted concentrations ppm of Ni^{2+}. Ni^{2+} concentrations interpreted of 1.0 and 5.0 ppm of Ni^{2+} solution. 1.0 ppm of 48 clock in the overall appearance of the plant normally.

1.0 ppm of the plant absorption and the amount of Ni^{2+} 51.27 µg/g measured.As long as the plant's normal physiological environment in which it operates in direct proportion to the concentration of observed (3.0 ppm are an anormally) 153.8 µg/g of Ni^{2+} ion biosorption. At 3.0 ppm absorbtion plant 76.93 µg/g plant an amount of 4.0 ppm received by it with the, 5.0 ppm again decreased amount of 32.06 µg/g.

The plant with 1.6 g wet weight has 0.018 ppm standard absorbance at 1.0 ppm concentration and its samples absorbance has been measured 0.001 ppm. After 72 h, the amount of Ni^{2+} taken by plant 57.68 µg/g. The amount of per hectare is 2584064 mg. Absorption by plants is normal at this concentration of Ni^{2+}.

The plant with 2.1 g wet weight has 0.037 ppm standard absorbance at 2.0 ppm concentration and its samples absorbance has been measured 0.008 ppm. After 72 h, the amount Ni^{2+} taken by plant 74.47 µg/g. The amount of per hectare is 3336256 mg. Shows the same reception concentration of 1.0 ppm.

The plant with 1.6 g wet weight has 0.056 ppm standard absorbance at 3.0 ppm concentration and its samples absorbance has been measured 0.004 ppm. After 72 h, the amount of Ni^{2+} taken by plant 173.06 µg/g. The amount of per hectare is 7753088. In this concentration Ni^{2+} ion was taken maximum level. Absorption increased related to physiological activities.

The plant with 1.5 g wet weight has 0.076 ppm standard absorbance and 4.0 pp concentration and its samples absorbance has been measured 0.022 ppm. After 72 h, the amount of Ni^{2+} taken by plant 189.7 µg/g. The amount of per hectare is 8498560 mg. As in the previous concentration to absorption very high.

The plant with 1.6 g wet weight 0.010 ppm standard absorbance and 5.0 ppm concentration and its samples absorbance has been measured 0.035 ppm. After 72 h, the amount of Ni^{2+} taken by plant 8498560 mg. As in the previous concentration to absorption very high.

The plant with 1.6 g wet weight 0.010 ppm standard absorbance and 5.0 ppm concentration and its samples absorbance has been measured 0.035 ppm. After 72 h the amount of Ni^{2+} taken by plant 198.7 µg/g. The amount of per hectare is 8901760 mg. It is evident that Ni^{2+} the content of the plant increased with increasing time and concentration.

Amounts of Ni^{2+} absorbed by *Nasturtium officinale* plants prepared with different wet weights and different Ni^{2+} concentration with 72 h: 1.0 ppm nickel solution for 72 h in the thickening of the adjacent regions of the root of the plant is yellowing of the lower leaves is seen. Peak buds are developing. The roots emerge negative geotropism. A large part of the leaves were yellow for Ni^{2+} 2.0 ppm of 4.0 and 5.0 ppm of solutions of Ni^{2+} is completely dead plants. Internodes is prolonged. Old leaves are shed formed by both the leaves and the root meristem and axillary youth.

Plant 57.68 µg/g of 1.0 and 2.0 ppm of uptake was a 74.47 µg/g, such as 3.0 ppm 173.06 µg/g. At 4.0 ppm, 189.7 and 198.7 µg/g of 5.0 ppm in the metal health is loaded. These concentrations and during this time due to the effect of plant Ni^{2+}carcinogen observed morphological changes in the overall structure of the plant. 3.0 ppm thoroughly wrinkled leaves.

RESULTS AND DISCUSSION

The results may be compared with those for the different species of plants. The levels of heavy metals in plant vary in various species and different aquatic environment. In laboratory condition, plants were exposed to prepared stock solution of copper, cadmium and nickel metals with 1.0, 3.0, 5.0 and 7.0 ppm concentration metal solutions in certain periods (24, 48, 72 and 96 h) and changing amount of accumulation of plants in depending on time and concentration was measured by atomic absorption spectrometer. As a result of data evaluation, it was found out that cadmium, copper and nickel materials were accumulated in different ratio by four aquatic plants in depending on time and concentration for all metals was materialized on the fourth day[14].

Heavy metal absorption related to industrial development in our environment has been removed by bacterium, fungus, algae and high plants such as *Lemnaminor* and *Nasturtium officinale*. We have chosen *Nasturtium officinale* for biosorption of Ni^{2+}. Same weighted plants were placed into Erlenmeyer flasks different Ni^{2+} concentrations. Then after 24, 48 and 72 h amount of Ni^{2+} ion in water was determined. As a result, it was seen that plants in with low Ni^{2+} concentration medium biosorped all heavy metals in medium. When the time flowed and concentration increased plants deformed gradually starting from their roots. Though some plants grown at 4.0 ppm biosorped less than 5.0 ppm it was seen that it was exceptional and it couldn't be generalized. Eventually, it can be expressed that *Nasturtium officinale* can be used biosorption of both Ni^{2+} ions and other heavy metals, especially in low metal ion concentration.

REFERENCES

1. T. Akar and S. Tuanli, *Bioresour. Technol.*, **97**, 1780 (2006).
2. Z. Aksu, *Purif. Technol.*, **21**, 285 (2001).
3. S. Al-Asheh and Z. Duvnjak, *Biotechnol. Progr.*, **11**, 638 (1995).
4. G. Bayramoglu, S. Bekta and M.Y. Arica, *J. Hazard. Mater.*, **101**, 285 (2003).
5. J.S. Chang, J.C. Huang, C.C. Chang and T.J. Tarn, *Water Sci. Technol.*, **38**, 171 (1998).
6. Y. Opak-Kara, D. Basaran and C. Isikalan, *Asian J. Chem.,* **21**, 1176 (2009).
7. V. Okumus, D. Basaran and A. Onay, **22**, 455 (2010).
8. G. Yan and T. Viraraghavan, *Bioresour. Technol.,* **78**, 243 (2001).
9. D. Basaran and Y. Opak-Kara, *Asian J. Chem.*, **20** (2008).
10. Y. Kara, D. Basaran, I. Kara, A. Zeytunluoglu and H. Genç, *J. Agric. Biol.,* **3**, 281 (2003).
11. R.R. Brooks, Oxford University Press, London (1998).
12. H. Wang and J.M. Wood, *Environ. Sci. Technol.*, **18**, 106 (1984).
13. Z.R. Holan and B. Voleksy, *Biotechnol. Bioprocess Eng.*, **43**, 1001 (1994).
14. A. Zeytunluoglu and Y. Kara, *Bull. Environ. Contaminat. Toxicol.,* **79**, 609 (2007).