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Biosorption Method of Removal of Chromium(III) Accumulated with *Nasturtium officinale* in Water

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In present studies, *Nasturtium officinale* was used as a biosorption plant to remove Cr^{3+} present in water. For these studies, 0.1, 0.3, 0.5, 1.0, 2.0, 3.0, 4.0 and 5.0 ppm solution of Cr^{3+} has been prepared in water. *Nasturtium officinale* was immersed in the experimental solutions for 24, 48 and 72 h. The general apperance of the plants have been observed before and after 24, 48 and 72 h. The plants have been analyzed with atomic absorption for measuring the concentration. The initial and final values of concentration of Cr^{3+} have been found by drawing the calibration lines in UV region. The wet weight has been measured with sensitive balance. The amount of Cr^{3+} absorption by plant has been calculated with the dependence of the wet weight.

Key Words: Biosorption, *Nasturtium officinale*, Cr(III).

INTRODUCTION

Chromium(III) used in industry causes various health and environmental problems by accumulating on live tissue. To tackle with this issue, many bacterium, algae and high plants is used. Heavy metals such as chromium metal have been biosorped by using various primitive and high plants[1-8].

In present studies, *Nasturtium officinale* was used as a biosorption plant to remove Cr^{3+} present in water.

EXPERIMENTAL

Changes in general apearence of plant after biosorption of Cr^{3+} metal with 0.1 and 0.3 ppm concentration by *Nasturtium officinale*: As shown in Table-1, the plant with 1.8 g wet weight has 0.02 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 Cr taken by plant is 5.55 µg/g. The amount of Cr per hectare is 224000 mg.

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TABLE-1
QUANTITY OF Cr^{3+} BIOSORPED BY *Nasturtium officinale* WITH RESPECT TO WET WEIGHT AFTER 24, 48 AND 72 h

Wet weight (g)	Conc. (ppm)	Standard absorbance (ppm)	Sample absorbance (ppm)	h	Quantity of Cr^{3+} taken by plant (µg/g)	Per hectare (mg)
1.8	0.1	0.002	0.000		5.55	248640
1.6	0.3	0.007	0.000		18.75	840000
1.6	0.5	0.012	0.000		31.25	1400000
2.0	1.0	0.018	0.015	24	7.99	389912
1.8	2.0	0.036	0.020		45.60	2042880
2.1	3.0	0.050	0.014		106.06	4751488
2.2	4.0	0.060	0.034		85.13	3822784
1.6	5.0	0.074	0.054		85.46	4276608
2.0	1.0	0.018	0.009		28.24	1265152
1.8	2.0	0.036	0.012		75.68	3390464
2.1	3.0	0.050	0.010	48	118.90	5326720
2.2	4.0	0.060	0.030		97.60	4372480
1.6	5.0	0.074	0.033		184.05	8245440
2.0	1.0	0.018	0.004		45.11	2020928
1.8	2.0	0.036	0.009		86.93	3894464
2.1	3.0	0.050	0.005	72	134.99	6047552
2.2	4.0	0.060	0.016		140.56	6297088
1.6	5.0	0.074	0.028		205.14	9100272

Not: In calculations of Cr(III) concentration (K = 67.498; B= -0.1723).

The plant with 1.6 g wet weight has 0.07 ppm standard absorbance at 0.3 ppm concentration and its sample absorbance has been measured as 0.000 ppm. After 24 h, the amount of Cr taken by plant is 18.75 µg/g. The amount of Cr per hectare is 840000 mg. Much more absorption occured in comparison to plant with 0.1 ppm concentration.

The plant with 1.6 g wet weight has 0.012 ppm standard absorbance at 0.5 ppm concentration and its sample absorbance has been measured as 0.000 ppm. After 24 h, the amount of Cr taken by plant is 31.25 µg/g.The amount of Cr per hectare is 140000 mg. Much more absorption occured in comparison to plant with 0.1 ppm concentration.

The plant with 2 g wet weight has 0.018 ppm standard absorbance at 0.1 ppm concentration and its sample absorbance has been measured as 0.015 ppm. After 24 h, the amount of Cr taken by plant is 7.99 µg/g. The amount of Cr per hectare as mg is 389912 mg. Much more absorption occured in comparison to plant with 0.1 ppm concentration. According to these results little metal ion is biosorped. This result can be attributed to its sytological structure.

The plant with 1.8 g wet weight has 0.036 ppm standard absorbance at 2 ppm concentration and its sample absorbance has been measured as 0.02 ppm. After 24 h, the amount of Cr taken by plant is 45.6 µg/g. The amount of Cr per hectare as mg is 2042880 mg.

The plant with 2.1 g wet weight has 0.05 ppm Standard absorbance at 2 ppm concentration and its7 sample absorbance has been measured as 0.014 ppm. After 24 h, the amount of Cr taken by plant is 106.06 µg/g. The amount of Cr per hectare as mg is 4751488 mg. Maximum metal ions has been absorbed in comparison to others.

The plant with 2.29 g wet weight has 0.06 ppm standard absorbance at 4 ppm concentration and its sample absorbance has been measured as 0.034 ppm. After 24 h, the amount of Cr taken by plant is 85.33 µg/g. The amount of Cr per hectare as mg is 3822784 mg. Lesser biyosorption is occured in comparison to the concentration of 3 ppm.

The plant with 1.6 g wet weight has 0.074 ppm standard absorbance at 5 ppm concentration and its sample absorbance has been measured as 0.054 ppm. After 24 h, the amount of Cr taken by plant is 95.46 µg/g. The amount of Cr per hectare as mg is 4276608 mg. It is a usual absorption.

Evaluation of general morphological apearence of *Nasturtium officinale* in solution of Cr^{3+} with 0.1 ppm and 3 ppm after 24 h: The plants in Cr^{3+} solution with 0.1; 0.3 and 0.5 ppm has been completely absorbed after 24 h. While the plants in Cr^{3+} with 1 ppm persists its normal growth, the bottom leafs turns pale. The radicals are alive and the general morphological apearence of plant remains almost same. In 24 h, 18.75 µg/g ion has been taken from the vicinity. Leaf also starts to decay at 3 ppm, fringe (leaves) roots doesnt change.

The plant with 106 µg/g at this concentration made extremely high biosorption. It is assumed that this process is achieved dependent on the density of physological activity. The plant with 4 ppm has been deformed with a big measure. The bottom leaves has been turned pale and the roots remained unchanged. 85.33 µg/g of biosorption has been achieved in 24 h. The plant with 5 ppm has lost its liveliness property and the quantity of its biosorption was 95.46 µg/g.

Quantity of Cr^{3+} biosorption of plants (*Nasturtium officinale*) grown in solution with different Cr^{3+} concentration and different wet weight: As shown in Table-1, the plant with 2 g wet weight has 1 ppm concentration and 0.018 ppm standard absorption and its sample absorbance has been calculated 0.009 ppm. The Cr^{3+} quantity of the sample taken from water is 28.24 µg/g after 48 h. The quantity per hectare is 1265152 mg. The biosorption in 48 h is much more than the biosorption in 24 h. It means that the deformation has not seen yet. At same table the plant with 1.8 g wet weight has 0.038 ppm standard absorbance at 2 ppm concentration and its

sample absorbance has been calculated as 0.012 ppm. The quantity of Cr^{3+} taken from water is 75.68 in 48 h. The quantity per hectare is 3390464 mg. There is an increase in this plant.

The plant with 2.1 g wet weight has 0.05 ppm standard absorbance at 3 ppm concentration and its sample absorbance has been measured as 0.01 ppm. In 48 h, the quantity of Cr taken from the vicinity by the plant is 118.9 µg/g. The quantity taken per hectare is 5326720 mg. Much more absorption has come true compared with absorption made in 24 h.

The plant with 2.2 g wet weight has 0.06 ppm standard absorbance at 4 ppm concentration and its sample absorbance has been measured as 0.03 ppm. In 48 h, the quantity of Cr taken from the vicinity by the plant is 118.9 µg/g. The quantity of Cr^{3+} absorbed by plant is 97.6 µg/g after 48 h. The quantity taken per hectare is 4372480 mg. Nose dive has been recorded with taken metal.

The plant with 1.6 g wet weight has 0.074 ppm standard absorbance at 5 ppm concentration and its sample. Absorbance has been measured as 0.033 ppm. After 48 h, the amount of Cr taken by plant is 184.05 µg/g. The amount of Cr per hectare as mg is 8245440 mg. In here,The absorption of Cr^{3+} is extremely high.

General morphological view of *Nasturtium officinale* in 1.0 ppm Cr^{3+} and 3.0 ppm Cr^{3+} solutions after 48 h: At 1.0 ppm, bottom leaves turned pale. Some parts of leaves were abscission. Roots were undamwetd. Internodes of plant got longer. Amount of chrome gotten by plant was 28.24 µg/g.

At 2.00 ppm, 75.68 µg/g of metal was absorbed. Leaves at upper side of plant were in good health. Eave roots departed from between nodes.

At 3.0 ppm, 118. 9 µg/g of metal was absorbed. Absorbed leaves remained in the solution. The height of plant was in standard. In this concentration, Cr^{3+} ion was taken in maximum level. Absorption increased related to physiological activities. At 5.0 ppm, 184.05 µg/g of metal was absorbed.

Amounts of Cr^{3+} absorbed by *Nasturtium officinale* plants prepared with different wet weights and different Cr^{3+} concentrations within 72 h: In 1.0 ppm concentration, standard absorption of 2.0 wet weighted plant was 0.018 ppm and its sample absorption calculated as 0.004 ppm. After 72 h, amount of chrome in water taken by plant was 45.11 µg/g. Biosorption amount per hectare was 20209280 mg.

In 2.0 ppm concentration, standard absorption of 1.8 wet weighted plant was 0.038 ppm. And its sample absorption determined as 0.004 ppm. After 72 h, amount of chrome in water taken by plant was 86.93 µg/g. Biosorbed amount per hectare was 3894464 mg.

In 3.0 ppm concentration, standard absorption of 2.1 wet weighted plant was 0.05 ppm. And its sample absorption determined as 0.005 ppm. After 72 h, amount of chrome in water taken by plant was 134.99 µg/g. Biosorbed amount per hectare was 60475522 mg.

In 4.0 ppm concentration, standard absorption of 2.1 wet weighted plant was 0.06 ppm. And its sample absorption determined as 0.016 ppm. After 72 h, amount of chrome in water taken by plant was 140.56 µg/g. Biosorbed amount per hectare was 6297088 mg.

In 5.0 ppm concentration, standard absorption of 1.6 wet weighted plant was 0.074 ppm. And its sample absorption determined as 0.004 ppm. After 72 h, amount of chrome in water taken by plant was 205.14 µg/g. A Biosorbed amount per hectare was 9190272 mg. Herein, there is an increase at biosorption.

General morphological appearance of *Nasturtium officinale* in 1.0 ppm Cr^{3+} and 3.0 ppm Cr^{3+} solutions after 72 h: Some changes started to appear in the general wives of plants at 1.0 ppm. First changes were seen at bottom leaves. In this concentration there was an sorption about 45.11 µg/g at 2.0 ppm morphological abnormality increased. Lengthen was determined at intermode. Bottom leaves turned yellow. 86.93 µg/g biosorption was observed. Although abnormality continued at 3.0 ppm, maximum biosorption (134.00 µg/g) was observed 140.56 µg/g ion was taken at 4.0 ppm. Plant totally deformed. Very high amount of chrome ions (205.14 µg/g) was absorbed at 5.0 ppm. Here, despite of being in high concentrated chrome ions, there was a normal plant appearance.

RESULTS AND DISCUSSION

Heavy metal absorption related to industrial development in environment has been removed by bacterium, fungus, algae and high plants such as Lemna minor and *Nasturtium officinale*. We have chosen *Nasturtium officinale* for biosorption of Cr^{3+} ions. Same wet weighted plants were placed into erlenmeyer flasks different Cr^{3+} ion concentrations. Then after waiting 24, 48 and 72 h, amount of ions in water was determined. As a result, it was seen that plants in with low chrome concentration medium biosorbed all heavy metals in medium. When time flowed and concentration increased, plants deformed gradually starting from their roots. Though some plants grown at 4.0 ppm biosorbed less than at 5.0 ppm, it was seen that it was exceptional and it couldn't be generalized. Eventually, it can be expressed that Nasturtium can be used in biosorption of both Cr^{3+} ions and other heavy metals, especially, in low metal ion concentration.

REFERENCES

1. T. Akar and S. Tunali, *Biores. Technol.*, **97**, 1780 (2006).
2. Z. Aksu, *Sep. 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.*, **B101**, 285 (2003).
5. J.S. Chang, J.C. Huang, C.C. Chang and T.J. Tarn, *Water Sci. Technol.*, **38**, 171 (1998).
6. G.M. Gadd, *Experiantia*, **46**, 834 (1990).
7. M. Ledin, *Earth-Sci. Rev.*, **51**, 1 (2000).
8. G. Yan and T. Viraraghavan, *Biores. Technol.*, **78**, 243 (2001).

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