

Studies on Accumulation of Mn^{2+} by *Nasturtium officinale* in Water by Biosorption

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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. The study has been achieved *in vitro*. Air roots of the plant with the same number and morphology of leaf has been chosen. For biosorption of Mn^{2+} metal ions by *Nasturtium officinale*, the solutions were prepared as 0.1; 0.3; 0.5; 1; 2; 3; 4 and 5 ppm, respectively. Water samples has been prepared from 1000 ppm stock and put them to balon joje. After this process, the plants have been transferred to the erlens and wait for 24, 48 and 72 h. The erlens have been tightly closed with parafilm. The general appearance of the plants have been observed at the beginning and after 24 h. The plants has been analyzed with atomic absorption spectrometry by receiving 2 mL of water samples for calculation of concentration. The A and B values have been found by drawing the calibration lines in UV. The wet weight has been measured with sensitive balance. The quantity of Mn^{2+} absorption of plants has been calculated with the dependence of the wet weight.

Key Words: Biosorption, Mn^{2+} , Environmental pollution, *Nasturtium officinale*, Heavy metals.

INTRODUCTION

The Mn^{2+} ions known as heavy metal used in industry causes various health and environmental problems by accumulating on live tissue. To tackle with this problem, many bacterium, algae and high plants is used. Heavy metals such as Mn^{2+} ion have been biosorped by using various primitive and high plants¹⁻⁹.

EXPERIMENTAL

The changes in general appearance of plant after biosorption of Mn^{2+} metal with 0.1 and 0.3 ppm by *Nasturtium officinale*:

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TABLE-1
 QUANTITY OF Mn²⁺ BIOSORPED BY *Nasturtium officinale* WITH
 RESPECT TO WET WEIGHT AFTER 24.46 AND 72 h

Wet weight (g)	Concentration (ppm)	Standard absorbance (ppm)	Sample absorbance (ppm)	Hour	Quantity of Mn ²⁺ taken by plant (µg/g)	Per hectare (mg)
2.0	0.1	0.000	0.000		5.000	224000
1.9	0.3	0.015	0.000		15.780	706944
2.0	0.5	0.030	0.000		25.000	11200000
1.7	1.0	0.050	0.009	24	56.600	2535680
1.6	2.0	0.065	0.040		49.400	2213120
2.0	3.0	0.080	0.078		17.800	797440
2.0	4.0	0.110	0.050		120.700	5407360
2.1	5.0	0.170	0.058		148.180	6638464
1.7	1.0	0.050	0.006		63.300	2835840
1.6	2.0	0.065	0.030	48	73.100	3274780
2.0	3.0	0.080	0.025		117.900	5281920
2.0	4.0	0.110	0.033		152.800	6845440
2.1	5.0	0.170	0.035		189.500	8489600
1.7	1.0	0.050	0.000		58.820	2635136
1.6	2.0	0.065	0.015	72	108.500	4860800
2.0	3.0	0.080	0.020		127.300	5703040
2.0	4.0	0.110	0.017		183.000	8198400
2.1	5.0	0.170	0.028		202.145	9056328

Not: In calculations of Mn²⁺ concentration (K = 37.776; B= -0.3029).

As shown in Table-1, the plant with 1.9 g wet weight has 0.015 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 Mn²⁺ taken by plant is 15.78 µg/g. The amount of Mn²⁺ per hectare is 706944 mg.

The plant with 2.0 g wet weight has 0.030 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 Mn taken by plant is 25.0 µg/g. The amount of Mn²⁺ per hectare as mg is 1020000.

The plant with 1.7 g wet weight has 0.050 ppm standard absorbance at 1.0 ppm concentration and its sample absorbance has been measured as 0.009 ppm. After 24 h, the amount of Mn²⁺ taken by plant is 56.6 µg/g. The amount of Mn²⁺ per hectare as mg is 2535680. The plant with 1.6 g wet weight has 0.065 ppm standard absorbance at 2.0 ppm concentration and its sample absorbance has been measured as 0.040 ppm. After 24 h, the amount of Mn²⁺ taken by plant is 49.4 µg/g. The amount of Mn per hectare as mg is 2213120 mg. According to these results little Mn²⁺ ion is biosorped. This result can be attributed to its cytological structure.

The plant with 2.0 g wet weight has 0.080 ppm standard absorbance at 3.0 ppm concentration and its sample absorbance has been measured as 0.078 ppm. After 24 h, the amount of Mn^{2+} taken by plant is 17.8 $\mu\text{g/g}$. The amount of Mn^{2+} per hectare is 797440 mg.

The plant with 2.0 g wet weight has 0.110 ppm standard absorbance at 4 ppm concentration and its sample absorbance has been measured as 0.050 ppm. After 24 h, the amount of Mn^{2+} taken by plant is 120.70 $\mu\text{g/g}$. The amount of Mn^{2+} per hectare is 5407360 mg. Maximum metal ions has been absorbed in comparison to others^{9,10}.

The plant with 2.1 g wet weight has 0.170 ppm standard absorbance at 5.0 ppm concentration and its sample absorbance has been measured as 0.058 ppm. After 24 h, the amount of Mn^{2+} taken by plant is 148.18 $\mu\text{g/g}$. The amount of Mn^{2+} per hectare is 6638464 mg. Lesser biosorption is occurred in comparison to the concentration of 4.0 ppm.

Evaluation of general morphological appearance of *Nasturtium officinale* in solution of Mn^{2+} with 0.1 ppm and 3 ppm after 24 h

The plants in Mn^{2+} solution with 0.1; 0.3 and 0.5 ppm has been completely absorbed after 24 h. While the plants in Mn^{2+} with 1.0 ppm persists its normal growth, the bottom leaf turns pale. The radicals are alive and the general morphological appearance of plant remains almost same. In 24 h, 56.6 $\mu\text{g/g}$ ion has been taken from the vicinity. Leaf also starts to decay at 3 ppm, but fringe (eaves) roots do not change.

The plant with 17.8 $\mu\text{g/g}$ at this concentration made extremely high biosorption. It is assumed that this process is achieved on the density of physiological 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. 120.70 $\mu\text{g/g}$ 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 148.18 $\mu\text{g/g}$.

Quantity of Mn^{2+} biosorption of plants (*Nasturtium officinale*) grown in solution with different Mn^{2+} concentration and different wet weight

As shown in Table-1, the plant with 1.7 g wet weight has 1 ppm concentration and 0.050 ppm standard absorption and its sample absorbance has been calculated 0.006 ppm. The Mn^{2+} quantity of the sample taken from water is 63.30 $\mu\text{g/g}$ after 48 h. The quantity per hectare is 2835840 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 1.6 g wet weight has 0.065 ppm standard absorbance at 2 ppm concentration and its sample absorbance has been calculated as 0.030 ppm. The quantity of Mn^{2+} taken from water is 73.10 in 48 h. The quantity per hectare is 3274880 mg. There is an increase in this plant.

The plant with 2.0 g wet weight has 0.080 ppm standard absorbance at 3 ppm concentration and its sample absorbance has been measured as 0.025 ppm. In 48 h, the quantity of Mn^{2+} taken from the vicinity by the plant is 117.9 $\mu\text{g/g}$. The quantity

taken per hectare is 5281920 mg. Much more absorption has come true compared with absorption made in 24 h.

The plant with 2.0 g wet weight has 0.110 ppm standard absorbance at 4.0 ppm concentration and its sample absorbance has been measured as 0.033 ppm. In 48 h, the quantity of Mn^{2+} taken from the vicinity by the plant is 152.8 $\mu\text{g/g}$. The quantity of Mn^{2+} absorbed by plant is 97.6 $\mu\text{g/g}$ after 48 h⁹. The amount of Mn^{2+} per hectare is 6845440 mg. Nose dive has been recorded with taken metal.

The plant with 2.1 g wet weight has 0.170 ppm standard absorbance at 5 ppm concentration and its sample absorbance has been measured as 0.035 ppm. After 48 h, the amount of Mn^{2+} taken by plant is 189.5 $\mu\text{g/g}$. The amount of Mn^{2+} per hectare as mg is 8489600. In here, the absorption of Mn^{2+} is extremely high⁹.

General morphological view of *Nasturtium officinale* in 1.0 ppm Mn^{2+} and 3.0 ppm Mn^{2+} solutions after 48 h

0.1, 0.3 and 0.5 ppm concentrations were gotten by plant. At 0.1 ppm, bottom leaves turned pale. Some parts of leaves were abscission. Roots were undamweted. Internodes of plant got longer. Amount of Mn^{2+} gotten by plant was 63.30 $\mu\text{g/g}$.

At 2.00 ppm, 73.10 $\mu\text{g/g}$ of metal was absorbed. Leaves at upper side of plant were in good health. Eave roots departed from between nodes.

At 3.0 ppm, 117.9 $\mu\text{g/g}$ of metal was absorbed. Absorbed leaves remained in the solution. The height of plant was in standard. In this concentration Mn^{2+} ion was taken in maximum level. Absorption increased related to physiological activities.

Amounts of Mn^{2+} absorbed by *Nasturtium officinale* plants prepared with different wet weights and different Mn^{2+} concentrations within 72 h

In 1.0 ppm concentration, standard absorption of 0.050 ppm wet weighted plant was 1.7 g and its sample absorption calculated as 0.000 ppm. After 72 h, amount of Mn^{2+} in water taken by plant was 58.82 $\mu\text{g/g}$. Biosorption amount per hectare was 2635136 mg.

In 2.0 ppm concentration, standard absorption of 0.065 ppm wet weighted plant was 1.6 g. And its sample absorption determined as 0.015 ppm. After 72 h, amount of Mn^{2+} in water taken by plant was 108.5 $\mu\text{g/g}$. Biosorped amount per hectare was 4860800 mg.

In 3.0 ppm concentration, standard absorption of 0.080 ppm wet weighted plant was 2.0 g. And its sample absorption determined as 0.020 ppm. After 72 h, amount of Mn^{2+} in water taken by plant was 127.3 $\mu\text{g/g}$. Biosorped amount per hectare was 5703040 mg.

In 4.0 ppm concentration, standard absorption of 0.11 ppm wet weighted plant was 2.0 g. And its sample absorption determined as 0.017 ppm. After 72 h, amount of Mn^{2+} in water taken by plant was 183.0 $\mu\text{g/g}$. Biosorped amount per hectare was 8198400 mg.

In 5.0 ppm concentration, standard absorption of 0.17 ppm wet weighted plant was 2.1 g. And its sample absorption determined as 0.004 ppm. After 72 h, amount

of Mn^{2+} in water taken by plant was 205.14 $\mu\text{g/g}$. A biosorped amount per hectare was 9190272 mg. Here there is an increase at biosorption.

General morphological appearance of *Nasturtium officinale* in 1.0 ppm Mn^{2+} and 3.0 ppm Mn^{2+} 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 58.82 $\mu\text{g/g}$ at 2.0 ppm morphological abnormality increased. Lengthen was determined at intermode. Bottom leaves turned yellow. 108.5 $\mu\text{g/g}$ biosorption was observed. Although abnormality continued at 3.0 ppm, maximum biosorption (127.3 $\mu\text{g/g}$) was observed. 183.0 $\mu\text{g/g}$ ion was taken at 4.0 ppm. Plant totally deformed. Very high amount of Mn^{2+} ions.

(202,15 $\mu\text{g/g}$) was absorbed at 5.0 ppm. Here, despite of being in high concentrated Mn^{2+} ions, there was a normal plant appearance.

RESULTS AND DISCUSSION

Heavy metal absorption related to industrial development in our environment has been removed by bacterium, fungus, algae and high plants such as *Lemna minor*¹⁰ and *Nasturtium officinale*. We have chosen *Nasturtium officinale* for biosorption of Mn^{2+} ions. Same wet weighted plants were placed into erlenmeyer flasks different Mn^{2+} ions 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 Mn^{2+} concentration medium biosorped 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 biosorped 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 Mn^{2+} ions and other heavy metals, especially, in low metal ion concentration.

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