How to Cite:
Alkindi, E. S. K., & Sharba, F. Y. J. (2022). Ability of Eichhornia crassipes L. to absorb nickel from polluted water flowing into the Kufa River. *International Journal of Health Sciences*, *6*(S4), 12418–12424. https://doi.org/10.53730/ijhs.v6nS4.12000

Ability of Eichhornia crassipes L. to absorb nickel from polluted water flowing into the Kufa River

Eman Sajad Kamil Alkindi
Shiite Endowment office, Department of Religious Education, Najaf, Iraq

Furqan Yahya Jawad Sharba
Department of Biology, Faculty of Education for Girls, University of Kufa, Iraq
Corresponding author email: furqany.majeed@uokufa.edu.iq

***Abstract*---**The current study was conducted on the *Eichhornia crassipes* plant after collecting it, from the Ghazi River, one of the water channels branching from the Najaf Sea in the city of Najaf Al-Ashraf to reveal about its ability to absorb existing Nickel in the contaminated water of the Kufa River. The plant was dosed weekly with 7.1 mg/L of Nickel for 21 days after acclimatization plant in laboratory using plastic basins (10 L capacity) of equal dimensions, and accumulated inside its tissues when compared with control basins where, the concentration of Nickel in the roots was 0.59 mg/kg and in the leaves 0.32 mg/kg.As for the percentage of removal of Nickel mineral from water, the results showed the ability of *E.crassipes* to absorb Nickel to 99.4% of the total concentration it, in water. Then, the removal rate gradually decreased at the end of the experiment as a result of continuous bioaccumulation within its tissues until the Nickel absorption rate decreased to 94.4% of the total concentration. This leads us to the hypothesis that the *E.crassipes* has a high Nickel absorption capacity in the first days and gradually decreases as the element continues to accumulate inside the tissues of the plant.

***Keywords*---**Eichhornia crassipes, Kufa River, polluted water, nickel.

Introduction

The Nickel is found in acidic environments and is present in the form of oxides, carbons and slicks with iron (Al-Shammari, 2006) and in sulphide ores, and is present in some Iraqi fertilizers, and corresponds to cobalt in chrome, copper and manganese materials, and is deposited with manganese granules and is present

Manuscript submitted: 9 April 2022, Manuscript revised: 18 June 2022, Accepted for publication: 27 July 2022

in clay metals, solid household waste and animal fertilizer, nickel is considered from toxic ions that cause nausea, intestinal disorders and lung cancer, and the standard specifications allowed for ion nickel in natural waters amounted to 0.02 ppm the World Health Organization for 2007 and Iraqi, Specifications for 2001, it occurs in igneous rocks as a free metal or together with iron. Its atomic number 28 in the periodic table and its atomic weight is 58.71 and nickel is a hard and heavy metal and its concentration naturally in soil and water is less than 100, 0.005 respectively (McIlveen & Negusanti, 1994). Ni is also introduced to the environment from human activities such as mining, fuel burning, domestic and industrial waste and the use of organic fertilizers (Alloway& Salih, 1995) Also plays a role in metabolism in micro-nitrogen-proven technologies as it is essential for the action of the Nitrogenase enzyme and has an impact on the process of seed formation in the plant (Wetzel, 2001). Polluting water and soil with nickel has become a global problem (Salt *et al.*, 1995; Hadi and Aljanaby, 2022). In recent years, it has been inciting the contamination of nickel by all the world, including Asia, America and Europe (Zhao *et al.*, 2008). Nickel is a key element of the plant, but the concentration Ni of plant species is very low (0.05 – 10 mg/kg dry weight) (Nieminen, *et al.*, 2007). The plant is absorbed of nickel by the root system via passive diffusion and active transport (Seregin & Kozhevnikova, 2006), the absorption of nickel by the plant depends on its concentration in soil or water and the metabolism of the plant and the acidity of the soil or water and the presence of other metal (Cataldo *et al.*, 1978; Aschmann & Zasoski, 1987; Podar *et al.*, 2004; Antoniadis *et al.*, 2008). Water hyacinth is effective in removing contaminants present in sewage and wastewater such as organic pollutants and heavy metal (Loan *et al.,* 2014) *Eichhornia. crassipes* is one of the best macrophytes to be used as a phytoremediation agent because it removes pollutants from wastewater efficiently while having a high tolerance to the polluted environment (Ebel *et al*., 2007; Medhat and Aljanaby, 2022), Phytoremediation is a modern technique that has a wide importance in the field of wastewater treatment because of many advantages, especially low cost, which is environmentally friendly technology (Dadrasnia *et al.,* 2015). Nearly 400 taxa of terrestrial plants have been identified as hyper accumulators of various metalloids and metals (Ni, Cu, CD, Mn, Zn, Pb, Co, TL, Sb, As and Se) (Baker *et al.*, 2000).

Material and Methods

Collection of plants

The current study conducted between December 2021 to February 2022. Where, collected aquatic plants *Eichhornia crassipes* from Al-ghazi river (one of the small reveries of Sea Al-Najaf) in Najaf city .They were brought to the laboratory in polyethylene bags and well washed with river water. Then, they were washed several times with tap water to clean from the dirt and materials that attached then, planted for 14 days to adapt the plant to live in the tap water basins. The aquatic plant was checked using Iraq-specific references (Al-Saadi and Al-Mayah 1983). While polluted water taken from Kufa River / Al-Brakiya region where discharged water from Water Treatment Station (WTS)**.**

Experimental design

The experiment was designed as 12 basins Then, placed plants for 2 week in the adaptation basins (enclosures filled with tap water where samples are placed before planting); after acclimation, the samples transport to agriculture enclosures; it's a plastic enclosures all were equal dimensions (40cm length x 25cm width x 20cm height) filled with 10 liters of water per enclosure and water level was in each enclosure maintained at a same level (compensate the shortfall resulting from evaporation). Then, plant was exposed to chosen concentrations of the Heavy Metals (nickel=7.1mg/l) in (0, 7^{th} and 14^{th}) day, , and the measurements were taken every 7 days in (7^{th}, 14^{th} and 21^{st}) day, with constant Conditions for all containers (Figure 1).

Figure 1: *Eichhornia crassipes* plant during lab culture

Nickel solution

A standard solution of nickel was prepared with a concentration of (1000 ppm) from dissolving 1 gram of pure nickel metal in a few concentrated nitric acid and then diluted with distilled water and the acid value was equated by adding a strong alkaline (sodium hydroxide) until the acid value is equal (pH=7) and then the volume was completed to 1000 ml with distilled water to become the final focus (1000 ppm) pure metal.

Plant samples

Prepare the samples for digestion: the plant samples exposed to the heavy metal were brought and washed in tap water 3 times, then washed with distilled water 3 times, the root parts were isolated from the parts of the leaves, cut into small pieces to facilitate the drying process, placed in glass implant dishes and placed in the oven at a temperature of 60 ^{0}c, until the samples reached the stage of complete dehydration and weight stabilization. The samples were then crushed with a ceramic mortar to avoid contamination, after completing the process of drying and grinding plants, ready to digest.

Results

Nickel (Ni) metal concentration in water

Control basins didn't record clear values of the amount of nickel in water, ranging between 0.0029mg/l to 0.0017mg/l throughout the experiment, while treatment basins recorded a continuous increase over the study period, which was less valuable in the first day with 0.0021mg/l and 0.0396 mg/l in the 21^{ts} day (table 1). Where the value in the leaves rise in 7th day to reach the highest absorption in 14th and then this value decreases and rises in the roots of the basins of treatment.

Table 1: Concentration of Ni mg/L in water

Duration	Control	Treatment	LSD	P- value
	Mean ±SD	Mean ±SD		
0 day	0.0021±0.0001	0.002±0.0003	0.00042	0.0001*
7 days	0.0029±0.0002	0.004±0.0001		
14 days	0.0017±0.0001	0.005±0.0007		
21 days	0.0017±0.0002	0.04±0.0005		

Nickel (Ni) concentration in the roots

Control basins recorded a rise value during 14th days and then returned to decline in the last 7 days. So, the highest reading was in the 14th day with 0.0352 mg/kg and the lowest reading in the 21st day with 0.0074 mg/kg while the treatment basins saw a continuous rise, so it was the lowest reading at the first day by 0.0135 mg/kg and the highest reading in the 21st day with 0.59255 mg/kg (table 2).

Table 2: Concentration of Ni mg/kg in Root

Duration	Control	Treatment	LSD	P- value
	Mean ±SD	Mean ±SD		
0 day	0.014±0.0001	0.014±0.0001	0.00027	0.0001*
7 days	0.014±0.0001	0.014±0.0002		
14 days	0.035±0.0002	0.017±0.0001		
21 days	0.007±0.0002	0.593±0.0005		

Nickel element in the leaves

Control basins recorded a rise at the beginning of the experiment and then gradually decreased over time where they were the highest value in 0 day with 0.0871mg/kg while the lowest reading appeared in the 21st day with 0.0074 mg/kg. On the other hand, treatment basins recorded a high rise during the first 14 days even 0.3267 mg/kg and then declined in 21st day to reach the value of 0.0349 mg/kg (table 3).

Table 3: Concentration of Ni mg/kg in Leaf of control and treatment basins

Duration	Control	Treatment	LSD	P- value
	Mean ±SD	Mean ±SD		
0 day	0.087±0.0001	0.087±0.0002	0.00044	0.0001*
7 days	0.087±0.0005	0.048±0.0003		
14 days	0.017±0.0003	0.327±0.0006		
21 days	0.007±0.0001	0.035±0.0004		

Discussion

Nickel concentration in water

Non-recording any value is adding of Nickel to the control basins, but showed high value of the treatment basins is due to the addition of this metal to these basins.

Nickel content in root

The height of the nickel element at the roots of the control basins is due to the fact that the plant absorbed the element in the water and after the metal ran out it gradually began to decrease, but the constant rise in the roots of the treatment basins is due to the continuous addition of this element to the basins.

Nickel content in leaves

The high value of nickel in plant leaves in control basins is due to the absorption of nickel coming from the root, which the root absorbed from the water during the early days and after the quantity finishing, the supply of the leaves with the element stopped by the root. The decrease in the element in plant leaves in treatment basins, after a rise seen in the leaves in the early 14 days has several explanations that may have been disposed of by different mechanisms as mentioned earlier, This element can be consumed by other microorganisms coexisting on these plants and we have observed the presence of these organisms (Insects) during the experiment. Peterson *et al.*, (2003) contrast with the mineral concentration in invertebrates they collected in Portugal, where they are with and against over accumulation species, where they found an increase in nickel concentration in the Invertebrates present in nickel-accumulating places, suggesting that nickel may be transported within dietary levels.

Conclusions

1- The ability of the water hyacinth plant to phytoremediation plants by absorbing heavy elements in contaminated water and accumulating them within their tissues.
2- It was observed that the peak absorption of heavy elements by root was in 21^{ts} day.
3- *Eichhornia crassipes* plant was distinguished by its superior ability to remove the elements of nickel from contaminated water.

References

Alaa Nasser Al-Shammari, Hydrology and Hydrochemical, Al-Rehab Region\South and Southwest of Samawah City,Master's Thesis (Unpublished Data),Faculty of Science,University of Baghdad,2006,p. 72(aerobic)

Alloway .B. J, in Heavy Metal in Soils (Ed: B. J. Alloway), 2nd ed., Blackie Academic and Professional, London 1995, pp. 25 – 34

Al-Saadi, H. A., & Al-Mayah, A. A. (1983). *Aquatic plants of Iraq. Cent. Arab*Gulf. Univ. Basrah . (Arabic).

Antoniadis.V, J. S. Robinson, B. J. Alloway, Effects of short-term pH fluctuations on cadmium, nickel, lead, and zinc availability to ryegrass in a sewage sludge-amended field, Chemosphere 2008, 71, 759 – 76.

Aschmann. S. G, R. J. Zasoski, Nickel and rubidium uptake by whole oat plants in solution culture, Physiol. Plant. 1987, 71, 191 – 196.

Baker AJM, McGrath SP, Reeves RD, Smith JAC (2000) Metal hyperaccumulator plants: a review of the ecology and physiology of a biological resource for phytoremediation of metal-polluted soils. In: Terry N, Ban˜ uelos G (eds) Phytoremediation of contaminated soil and water. Lewis Publ, Boca Raton, pp 85–107

Cataldo .D. A, T. R. Garland, R. E. Wildung, Nickel in plants: I. uptake kinetics using intact soybean seedlings, Plant Physiol. 1978, 62, 563 – 565.

Chilán, J. C. H., Torres, S. G. P., Machuca, B. I. F., Cordova, A. J. T., Pérez, C. A. M., & Gamez, M. R. (2018). Social impact of renewable energy sources in the province of Loja: Ecuador. *International Journal of Physical Sciences and Engineering*, *2*(1), 13–25. https://doi.org/10.29332/ijpse.v2n1.79

Dadrasnia .A, A. Salmah, C.U. EmenIke, N. Shahsavari, Remediation of contaminated media using organic material supplementation, Pet. Sci. Technol. 33 (2015) 1030–1037

Ebel, M.; Evangelou, M.W.; Schaeffer, A. Cyanide phytoremediation by water hyacinths Eichhornia crassipes). Chemosphere 2007, 66, 816–823. [CrossRef]

Hadi, H. I. & Aljanaby, A. A. J. (2022). Helicobacter Pylori-oncogenic protein cytotoxin-associated gene A and assessment of CD14 and CD163 in duodenal ulcer and gastric cancer patients. International Journal of Health Sciences, 6(S2), 839–851. https://doi.org/10.53730/ijhs.v6nS2.5134

Loan .N.T., N.M. Phuong, N.T.N. Anh, The role of aquatic plants and microorganisms in domestic wastewater treatment, Environ. Eng. Manage. J. 13 (2014) 2031–2038.

McIlveen .W. D., J. J. Negusanti, Nickel in the terrestrial environment, Sci. Total Environ. 1994, 148, 109 – 138.

Medhat, A. R., & Aljanaby, A. A. J. (2022). Epidemiology of typhoid fever in Balad City, Iraq. International Journal of Health Sciences, 6(S1), 1049-1063. https://doi.org/10.53730/ijhs.v6nS1.4834

Nieminen .T. M., L. Ukonmaanaho, N. Rausch, W. Shotyk, Biogeochemistry of nickel and its release into the environment, Met. Ions Life Sci. 2007, 2, 1 – 30

Peterson, L.R., Trivett, V., Baker, A.J.M., Aguiar, C. and Pollard, A.J. (2003) Spread of metals through an invertebrate food chain as influenced by a plant that hyperaccumulates nickel. Chemoecology, 13, 103J108.

Podar.D, M. H. Ramsey, M. J. Hutchings, Effect of cadmium, zinc and substrate heterogeneity on yield, shoot metal concentration and metal uptake by

.Brassica juncea: Implications for human health risk assessment and phytoremediation, New Phytol. 2004, 163, 313 – 324

Salt D. E. et al., Phytoremediation: A novel strategy for the removal of toxic metals from the environment using plants, BioTechnology 1995, 13, 468 – 474.

Seregin. I. V., A. D. Kozhevnikova, Physiological role of nickel and its toxic effects on higher plants, Russ. J. Plant Physiol. 2006, 53, 257 – 277.

Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2022). Post-pandemic health and its sustainability: Educational situation. *International Journal of Health Sciences*, *6*(1), i-v. https://doi.org/10.53730/ijhs.v6n1.5949

Thyagaraju, N. (2016). Water pollution and its impact on environment of society. *International Research Journal of Management, IT and Social Sciences*, *3*(5), 1-7. Retrieved from https://sloap.org/journals/index.php/irjmis/article/view/360

Zhao.J, G. Shi, Q. Yuan, Polyamines content and physiological and biochemical responses to ladder concentration of nickel stress in Hydrocharis dubia (Bl.) Backer leaves, BioMetals 2008, 21, 665 – 674.