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Analyzing the Harmful Effects of Arsenic Oxides on the Morphological and Biochemical Domains of the Water Lily Plant

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Abstract

Acute promyelocytic leukemia is a kind of cancer that is treated with the medication arsenic oxide (AsO). A water lily plant was used in the experiment as a source of bioremediation against water-dissolved AsO. The AsO was dissolved in water at various quantities (0, 100, and 200 mg/L). Metal trays were filled with water that had been dissolved with arsenic, and the lily plants were then submerged in the tainted water. The arsenic kit technique was used every day to check the amount of arsenic in the water. The lily plant was in excellent morphological order up until four days ago, and the lily plant's absorption was causing the concentration of dissolved arsenic to decline. Arsenic was significantly reduced in the water after the first week, indicating that water lilies had successfully absorbed it, although the plants' health was not good. AsO has hampered plant development, according to the findings of several biochemical studies conducted on plant components. According to the results of this article, the lily plant is not sensitive to arsenic pressure over a satisfactory concentration level.

Keywords: Arsenic Oxide (AsO), water lily, morphological and biochemical

Full length article

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1. Introduction

Arsenic is a heavy metal that is present in both the hydrosphere and the core of the planet, and its concentration is constantly rising as a result of both natural and man-made activity. By natural geological leaching from host sediments and rocks, arsenic in its many salt forms pollutes water and soils, especially groundwater. A variety of physiological, chemical, morphological, and anatomical abnormalities in crops are brought on by the irrigation of agricultural regions with such arsenic-contaminated water [1]. Arsenic contamination even has an impact on soil bacteria. By lowering soil fertility, harm to soil microbiology also indirectly leads to slower plant development. Drinking water with high levels of arsenic regularly may have harmful health impacts, such as skin problems, lung cancer, and cardiac disorders. As approximately 150 million public depends on arsenic-contaminated underground water, arsenic-contaminated water indeed poses one of the greatest hazards to world health [2]. The World Health Organization (WHO) has established a limit of 10 g/liter for the amount of arsenic that should be present in drinking water. A coagulation/filtration method is currently the most popular way to clean heavy metal-contaminated water [3].

This process includes extracting harmful gases first sending the polluted water over several filtrates that capture the contaminants and retain them for removal, followed by chemically conditioning the particles to aggregate into bigger particles that can be isolated and settled. The sludge-like byproduct that is created as a consequence of the impurities that settle and are trapped is one of the main issues with this procedure [4].The employment of these techniques for polluted water treatment and disposal is highly costly and disruptive to the environments around. Scientists are looking for innovative and affordable solutions to the pollution issue. The terms "phytoremediation" or phytoextraction refer to a brand-new and encouraging technique that has been generating attention for many years. Using plants to extract toxins from water involves drawing the impurities up through the plant's root system and into its main body. By thoroughly eliminating the plants and toxins, including carcinogenic metals like copper, chromium, and mercury, cleanup is made simpler and considerably less costly [5].The greatest focus is being placed on water lilies as phytoremediation aquatic plants. These plants are stunning aquatic blooming plants that are found all over the globe. The plant has flat-floating broadeningleaves that are rounded on both sides. It can do photosynthesis because of its greenish color. Some

Nymphaea species have also been used to clean wastewater and water tainted with soap and heavy metals [6].

Mineral trioxide and graphene oxide changed the morphology and biological potential of nanocomposites constructed of hydroxyapatite. The TEM micrograph of HAP/GO demonstrates the effect of the GO addition on the size reduction of the HAP grains to be shown on graphene wafers with diameters ranging from 11.4 to 28.5 nm. The mechanical qualities and weak antibacterial activity of HAP are drawbacks that restrict its use [7].By using nanoscale items, nanotechnology has emerged as one such cutting-edge strategy to enhance agricultural yield. Nanoparticles may be used in agriculture because of their capacity to penetrate cellular barriers. Nanoparticles are a common technique in contemporary farmingbecauseit can be tiny, readily soluble, and efficient for absorption by plants. Heat stress may occur under hot conditions. The tendency has become worse in recent decades due to global warming. Heat stress is often believed to be an increase in temperature that persists over a crucial threshold long enough to irreversibly impair plant growth [8].The function of NO when used as sodium nitroprusside (SNP) in cell signaling and its capacity to lessen the harmful effects of as when used as sodium arsenate in water hyacinth. The buildup of as by plants results in cellular damage, which complicates and restricts the use of phytoremediation techniques [9].The water hyacinth plant species was chosen because it has the most potential to be employed as an affordable and accessible bio-sorption material. It has the potential to significantly lower the effluent content. Small dye shops can be given access to a secluded wastewater disposal facility that is water hyacinth-planted. The usage of a wide range of synthetic products results in an effluent that is complicated and cannot be identified by a single effluent feature, which makes the treatment process more challenging and complex [10].Sodium heptahydrate arsenate (Na2HAsO47H2O) exposure of water mimosa to various concentrations was investigated for its phytoremediation capacity. The quantity and growth ratio of leaves and roots, as well as the diameters of the roots and shoots, all reduced as the amount of arsenic in the environment grew over time [11].The addition of biochar as incorporation and spreading exhibited the most effects. Following incubation, soil biochemical and microbiological metrics showed observable substantial changes at all rates compared to the control. The nation, farmers, and agricultural authorities now face a growing problem and cost connected with the clearance of these aquatic plants. This is especially true given ongoing water shortages and climate change [12].(MgO-NPs) may promote plant development and increase a plant's ability to withstand the harmful effects of heavy metals and metallic ions. Therefore, a lower level of reactive oxygen species (ROS) is preferred for optimum plant development, although modestly increased ROS levels are beneficial for triggering stress-related defensive responses [13]. Nevertheless, a high level of ROS that exceeds the limits is thought to be damaging to plants. To demonstrate groundwater and sediment arsenic presence and speciation, as well as how human activities affect the release of arsenic between the solid and liquid phases [14]. The samples were taken from a limited geographical agricultural region with endemic arsenicosis. As it poses a serious risk to public health, arsenic poisoning of groundwater has received substantial attention on a global scale. Yet, the mechanisms behind arsenic mobilization are still not fully understood [15].

This research describes the phytoremediation activity of water lilies, which was effective for a short time. To measure the level of arsenic in the water, the arsenic test method was employed daily. After one week, plants that had absorbed AsO from water were severely harmed. Water lilies were put through biochemical testing while taking into account their morphological condition. Much biochemical research on plant components has been undertaken, and the results show that AsO has hampered plant growth.

2. Materials and methods

The Department of Botany experimented to determine whether water lily plants could effectively remove dissolved AsO from water without harming themselves and to determine how long certain lily plants might demonstrate resilience to arsenic stress. The corresponding concentrations of dissolved AsO were used in each of the three steel trays: 0, 100, and 200 mg/L, correspondingly. The water in each tray was filled to the same volume. For two weeks, a water lily plant was left on each plate. To estimate arsenic decrease levels, water was tested every day using the arsenic kit. After a week, the plant began to wilt and its leaves began to scorch and blacken in color. Arsenic crystals were also beginning to seep from the stems.

2.1 Filtering and preserving

The stems, roots, and leaves of water lily plants were dismantled one by one after being removed from their respective pots. After being crushed up in a buffer containing 50 mM potassium phosphate, these plant components were centered for 15 minutes at a speed of 14,000 revolutions per minute. The above-mentioned buffer was used to retain the supernatants after centrifugation while different biochemical test were performed.

2.2 Total soluble proteins

For determining the amount of total soluble proteins, a slightly altered version of the technique that had been employed previously was used. After mixing in 2 ml of the Bradford Reagent, 1 ml of the supernatant was used, incubated for 15 to 20 minutes, and then the measurement at 595 nm was taken.

2.3 APX activity

This functioning was assessed using the accepted technique. The reaction mixture (1600 µl) included 400 l of enzyme extract, 0.5 mm ascorbic acid, 0.1 mm H_2O_2, and 50 mm potassium phosphate buffer (pH 7.0). At 290 nm, the absorbance was measured in comparison to a blank and Umg-1 protein served as a proxy for the enzyme activity.

2.4 H_2O_2 concentration

The methodology previously described was followed to obtain the H_2O_2 concentration. After that, 0.1 milliliters of the supernatant was combined with 10 millimeters of potassium phosphate buffer with a pH of 7.0, 1 millimeter of IKI, and 10 millimeters of potassium phosphate. The absorbance was measured at a wavelength of 390 nm.

2.5 Total phenolics

With a few adjustments, the Folin-Ciocalteu method was employed to evaluate total phenolics. Samples were mixed with 5 ml of the Folin-Ciocalteu reagent that had been diluted with water 1:10 v/v and 4 ml (75 g/l) of sodium carbonate. After shaking the tubes rapidly for fifteen seconds, they were left at a temperature of forty degrees Celsius for thirty minutes so that the color could develop. After that, the spectrophotometer was used to determine the absorbance at a wavelength of 765 nm.

2.6 MDA content

According to a technique described in the literature, malondialdehyde (MDA) was measured. 0.6% thiobarbituric acid 2ml was added to the 2 ml TCA. It was placed in a water bath and heated to 100 degrees Celsius for 20mins. Instantly after heating, frozen for 20 mins, and then centralization for 10 minutes at 10,000 rpm. A spectrophotometer was used to measure the resultant color at 532 nm.

3. Results and Discussions

Total soluble proteins:Protein solubility, a thermodynamic property, occurs when the protein concentration in a saturated solution approaches equilibrium with a solid phase, either crystalline or amorphous. Internal and external influences affect a material's solubility.

Figure 1 shows that under both levels of AsO stress, the concentration of soluble proteins reduced in all sections of the water lily (roots, stem, and leaves). Nevertheless, when were 200 mg/L and 100 mg/L stress compared, the second stress level indicated a greater loss in proteins all over the plant.

APX activity:An essential enzyme that eliminates hydrogen peroxide (H_2O_2) to stop oxidative damage is ascorbate peroxidase (APX), also known as a ROS scavenger.The three plant components of the water lily have decreased their APX activity concerning AsO stress. Compared to S2 and S3, S3 stress levels have significantly decreased APX activity, as shown in figure 2.

Hydrogen peroxide concentration:Hydrogen peroxide comes in a range of strengths or concentrations, depending on the intended use. One illustration of a typical concentration is 3%, which is the typical amount for household products. The percentage in various hair coloring and teeth whitening treatments ranges from 6 to 10%.

The findings of figure 3 clearly show that the water lily's roots, stems, and leaves had increased hydrogen peroxide concentrations in response to the administered two degrees of arsenic contamination. It seems that the second degree of stress was more significant to water lily plants when comparing the two levels of stress.

Total phenolics: The antioxidant activity of phenolic compounds may be traced back to the redox properties that they possess. Phenolic chemicals are important components of plants. The hydroxyl groups that are present in plant extracts are what give them their potency as free radical scavengers.According to the findings shown in figure 4, the water lily plant's total phenolic content decreased at both levels of S2 and S3 are corrupted by AsO, with the second degree of stress being the more severe of the two.

MDA contents: Malondialdehyde (MDA) concentration is a commonly used indicator to assess the degree of lipid peroxidation in plant tissue, which rises in response to oxidative stress.In comparison to the group that is free of this pollution, figure 5 shows that all three components of the water lily the roots, stems, and leaves had higher MDA contents after being exposed to S1 and S2 levels of AsO stress.

4. Conclusions

This study shows that whereas water lilies may reduce water pollution by removing AsO, they cannot completely eliminate it, at a certain concentration level, they become vulnerable to the negative effects of heavy metal stress. In light of the aforementioned findings, it is abundantly fine that pressure concentrations of 200 mg/L and 100 mg/L results in a higher Hydrogen peroxide and MDA content and a corresponding increase in the manufacturing of reactive oxygen species, which leads to the osmotic lysis of cells and the development of a disorderly environment within the cellular setting. Conversely, a decrease in phenolic and a deficiency in ascorbate peroxidase action prohibits auxins from creating ROS-scavenging proteins like glutathione S-transferees, whose function is to contaminate ROS molecules. As a result, because arsenic poisoning is causing grave environmental changes, significant efforts must be made to eliminate it. While the lily is commonly known that a plant that can phytoremediation, it was unable to withstand the risk of toxic metals for an extended period.The possibility for the AsO in the various studies and the improved AsO to help protect lily plants from harmful events in the future.

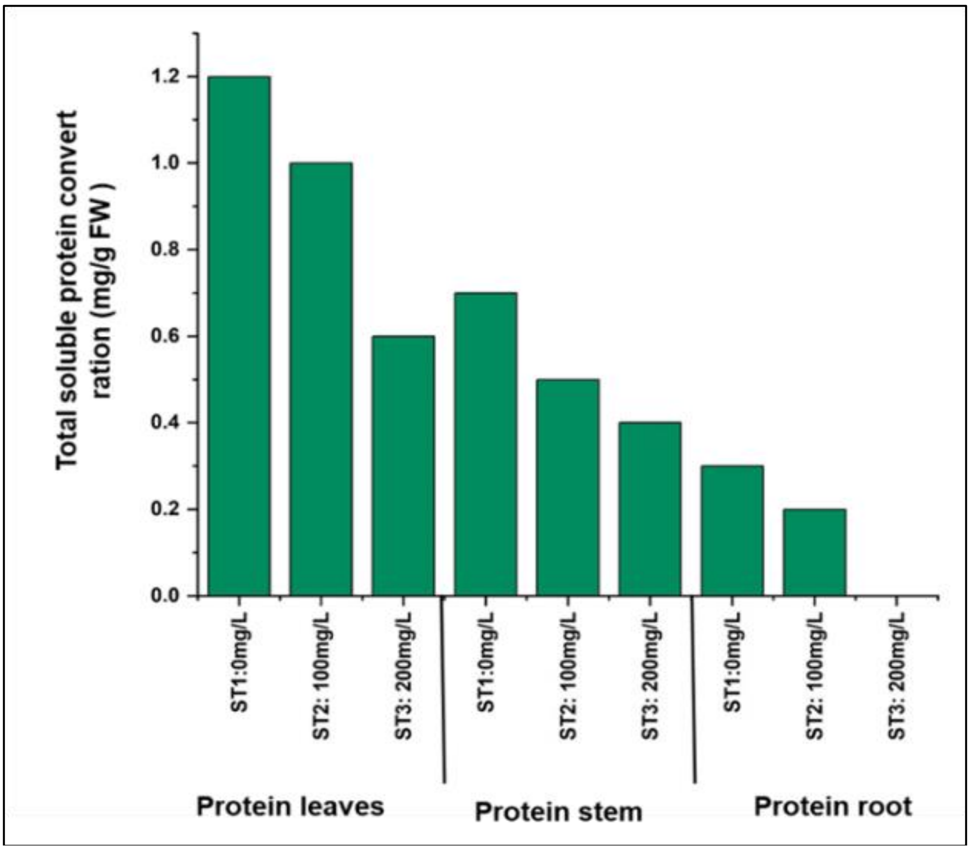

Figure 1: Total soluble proteins

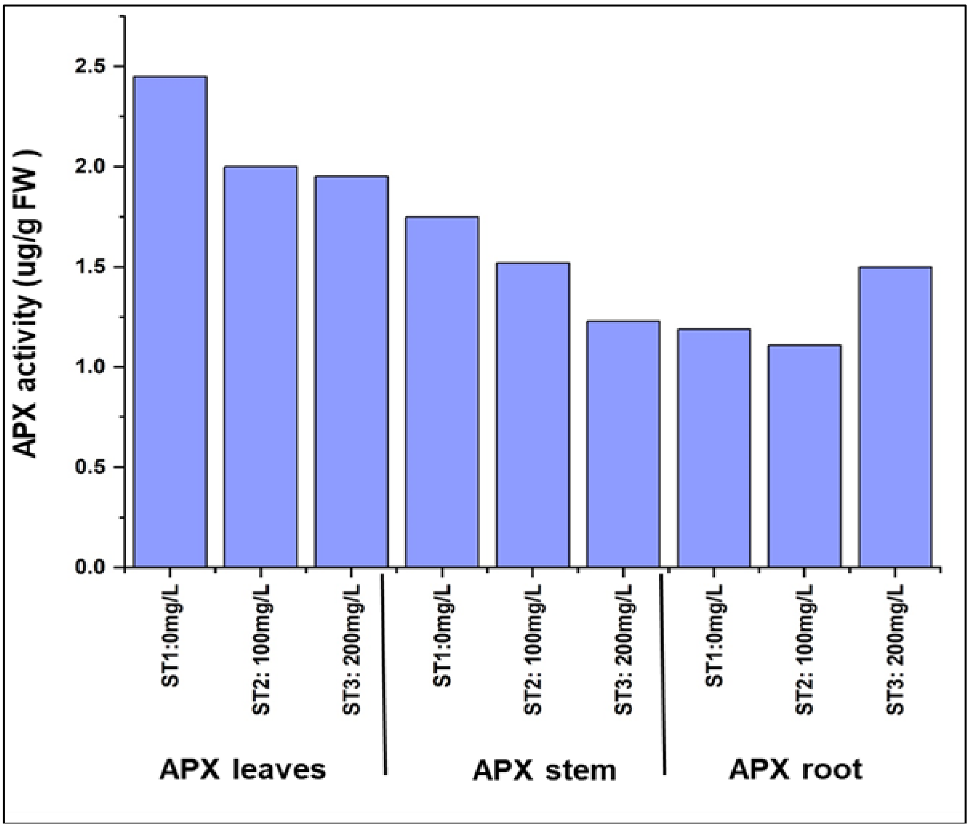

Figure 2: APX activity

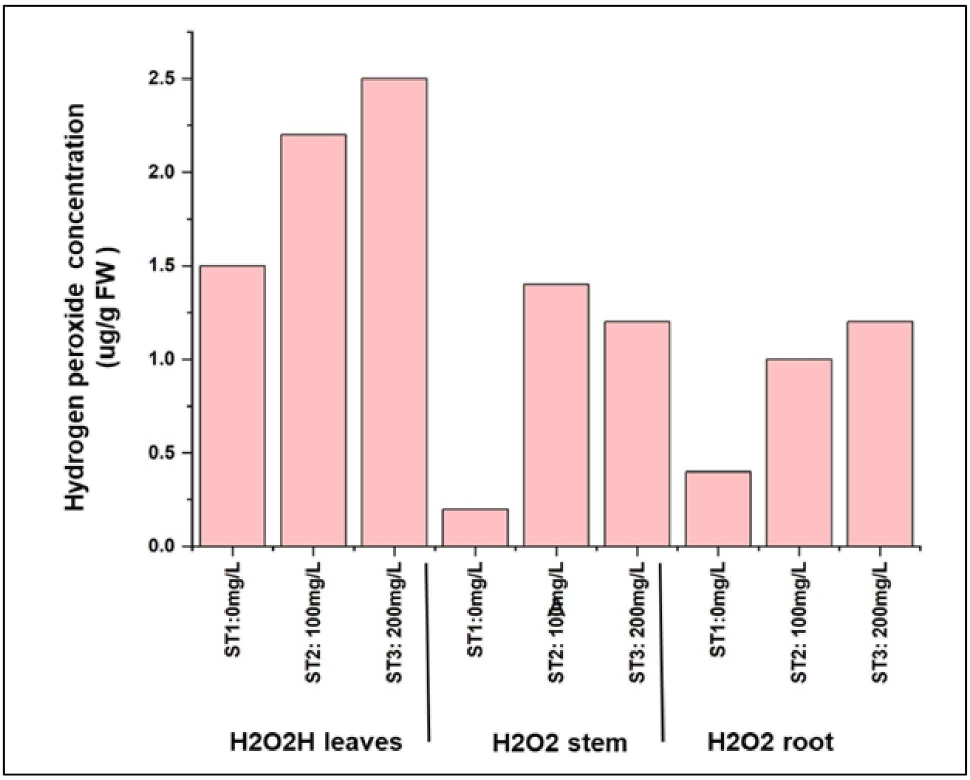

Figure 3: Hydrogen peroxide concentration

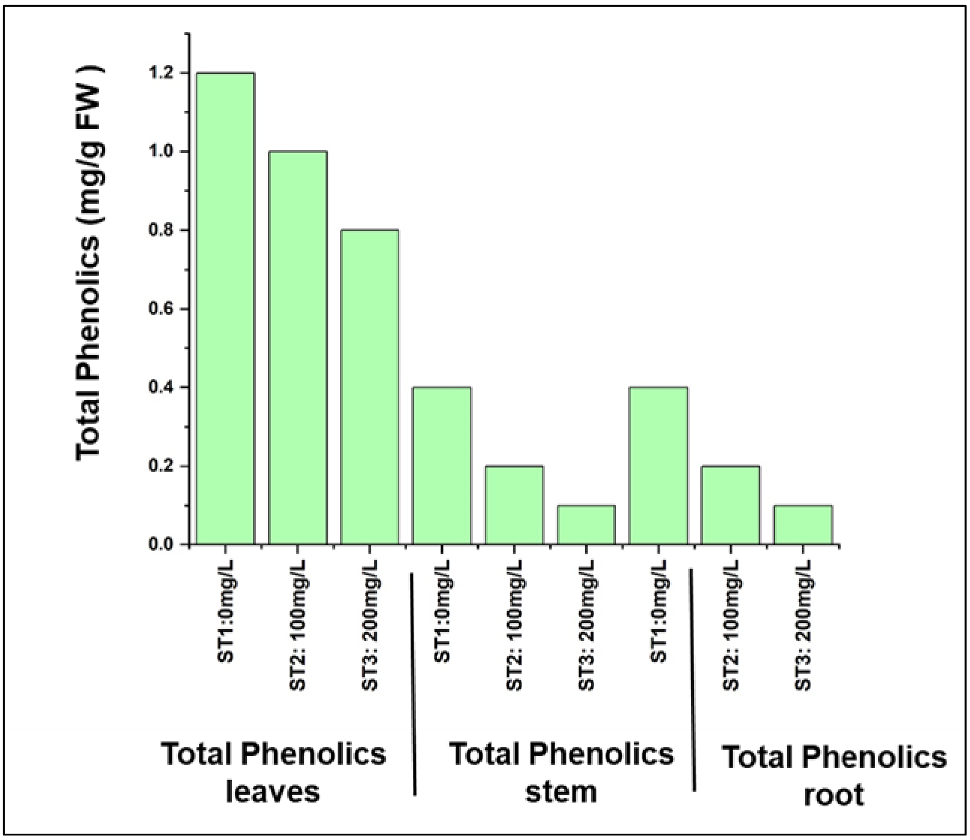

Figure 4: Total phenolics

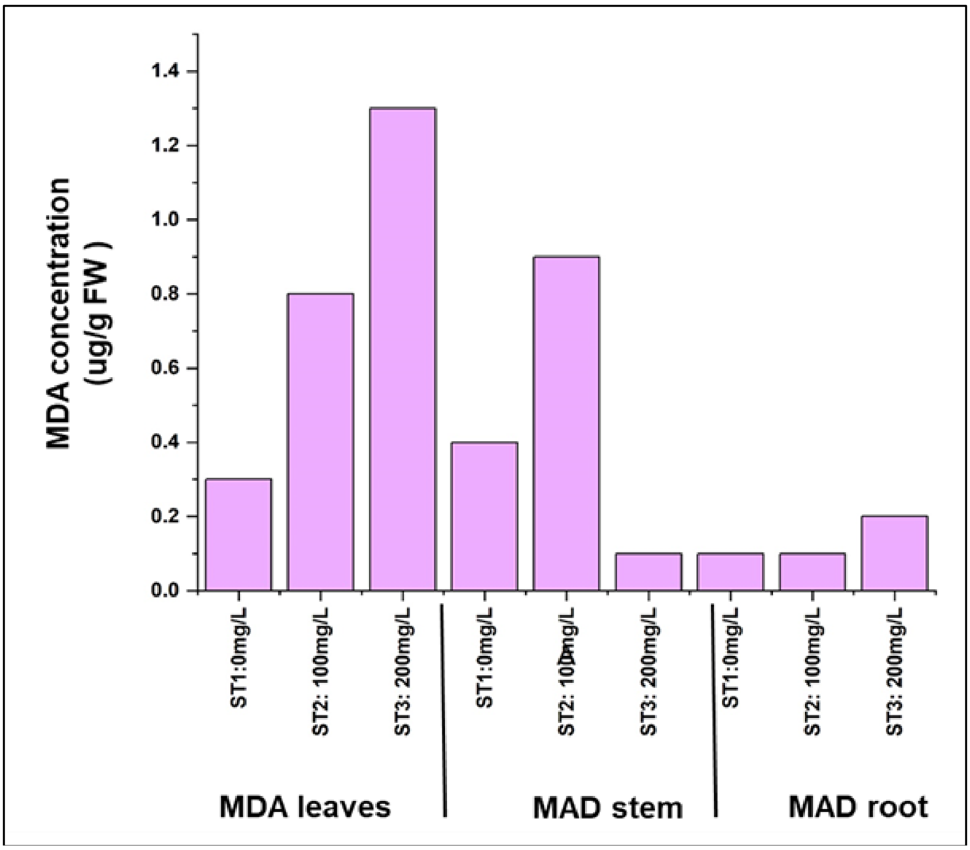

Figure 5: MDA concentration

References

[1] Z.Abbas,, F. Arooj, S. Ali, I.E. Zaheer, M. Rizwan, and M.A. Riaz (2019). Phytoremediation of landfill leachate waste contaminants through floating bed technique using water hyacinth and water lettuce. *International journal of phytoremediation*, *21*(13): pp.1356-1367.

[2] N. Begum, M.A. Ahanger, Y. Su, Y. Lei, N.S.A. Mustafa, P. Ahmad and L. Zhang, (2019). Improved drought tolerance by AMF inoculation in maize (Zea mays) involves physiological and biochemical implications. *Plants*, *8*(12): p.579.

[3] I. Harun, H. Pushiri, A.J. Amirul-Aiman, and Z. Zulkeflee, (2021). Invasive water hyacinth: Ecology, impacts and prospects for the rural economy. *Plants*, *10*(8):p.1613.

[4] B. Panneerselvam, and K.S. Priya, (2021). Phytoremediation potential of water hyacinth in heavy metal removal in chromium and lead contaminated water. *International Journal of Environmental Analytical Chemistry*:pp.1-16.

[5] N. Khorshidi, M. Parsa, D.R. Lentz, and J. Sobhanverdi, (2021). Identification of heavy metal pollution sources and its associated risk assessment in an industrial town using the K-means clustering technique. *Applied Geochemistry*, *135*:p.105113.

[6] S.B. Kakkalameli, A. Daphedar, M. Govindappa, and T.C. Taranath, EFFECT OF CHROMIUM ON MORPHOLOGICAL AND BIOCHEMICAL RESPONSES ON AQUATIC MACROPHYTE PISTIA STRATIOTES L.(WATER LETTUCE).

[7] M.E. El-Naggar, A. Elmushyakhi, A.G. Al-Sehemi, A. Kalam, H. Algarni, S.R. Salem, and M. Abou Taleb, (2022). Biomedical domains of the as-prepared nanocomposite based on hydroxyapatite, bismuth trioxide and graphene oxide. *Journal of Materials Research and Technology*, *19*:pp.3954-3965.

[8] J.M. Al-Khayri, R. Rashmi, R. Surya Ulhas, W.N. Sudheer, A. Banadka, P. Nagella, M.I. Aldaej, A.A.S. Rezk, W.F. Shehata, and M.I. Almaghasla, (2023). The Role of Nanoparticles in Response of Plants to Abiotic Stress at Physiological, Biochemical, and Molecular Levels. *Plants*, *12*(2):p.292.

[9] S. Bajpai, and P.R. Nemade, (2023). An integrated biorefinery approach for the valorization of water hyacinth towards circular bioeconomy: a review. *Environmental Science and Pollution Research*:pp.1-43.

[10] A. Shenoy, V. Bansal, and B.K. Shukla, (2022). Treatability of effluent from small scale dye shop

using water hyacinth. *Materials Today: Proceedings*, *61*:pp.579-586.

[11] N. Atabaki, N.A. Shaharuddin, S.A. Ahmad, R. Nulit, and R. Abiri, (2020). Assessment of water mimosa (Neptunia oleracea Lour.) morphological, physiological, and removal efficiency for phytoremediation of arsenic-polluted water. *Plants*, *9*(11):p.1500.

[12] A. El-Azeim, Z.M. Salah, and A.A. Hammam, (2021). Assessment of water hyacinth biochar as a soil amendment for sandy soils. *Journal of Soil Sciences and Agricultural Engineering*, *12*(6):pp.431-444.

[13] M. Faizan, J.A. Bhat, H.A. El-Serehy, M. Moustakas, and P. Ahmad, (2022). Magnesium Oxide Nanoparticles (MgO-NPs) Alleviate Arsenic Toxicity in Soybean by Modulating Photosynthetic Function, Nutrient Uptake and Antioxidant Potential. Metals, 12(12):p.2030.

[14] C.Li, J. Bundschuh, X. Gao, Y. Li, X. Zhang, W. Luo, and Z. Pan.(2022). Occurrence and behavior of arsenic in groundwater-aquifer system of irrigated areas. Science of The Total Environment, 838:p.155991.

[15] S. Panda, V.K. Tripathi, D.J. Shrinivasa, and R. Sharma, (2023). Arsenic Contamination of Groundwater in Indo-Gangetic Plain. *Hydrogeochemistry of Aquatic Ecosystems*:pp.85-95.