Libyan Medical Journal
https://lmj.ly/index.php/ojs/index

Original article

Assessment of Heavy Metal Levels in Pink and White Oleander Plants from Sabratha City

Abdulati E. Khalil[1], Ibtesam O. Amer[2]*, Abduraouf Al. Mohamed[2], Samira B. Abusiwil[1]

Citation: *Khalil A, Amer I, Mohamed A, Abusiwil S. Assessment of Heavy Metal Levels in Pink and White Oleander Plants from Sabratha City. Libyan Med J. 2024;16(2):95-100.*

Received: *30-06-2024*
Accepted: *20-08-2024*
Published: *26-08-2024*

Funding: *This research received no external funding.*

Conflicts *of Interest: The authors declare no conflict of interest.*

[1]Department of Laboratory, Faculty of Medical Technology Surman, University of Sabratha, Libya
2Department of Biotechnology & Genetic Engineering, Faculty of Medical Technology Surman, University of Sabratha, Libya
****Correspondence***. *ibtesam.amer@sabu.edu.ly*

Abstract

This study aimed to evaluate and compare the concentrations of heavy metals in pink and white oleander leaves collected from Sabratha, Libya. The research focused on determining the levels of heavy metals in these plants and comparing them with the permissible limits established by the World Health Organization (WHO). The research involved analyzing moisture, ash content, and heavy metals using standard methods and ICP-OES. The study found that moisture content in white oleander ranged from 11% to 14.8% and from 9% to 12% in pink oleander. Ash content varied between 9.3% and 12.4% in white oleander and 7.3% to 10.9% in pink oleander. Most heavy metals, including manganese, iron, copper, and zinc, were within WHO limits, except for slightly elevated arsenic levels. Lead and molybdenum were undetectable. The concentrations of most heavy metals in both pink and white oleander samples were found to be within the safe limits set by the WHO, indicating that these plants are generally safe. The findings contribute valuable information on the environmental quality and safety of oleander plants in the region.

Keywords: *Heavy Metals, Oleander, ICP-OES, Environmental Safety, WHO Standards.*

Introduction

Heavy metal contamination is a pressing environmental issue, particularly in regions experiencing industrialization and urbanization. These metals, including lead (Pb), cadmium (Cd), and mercury (Hg), among others, can accumulate in the environment and pose significant risks to human health and ecosystems. Plants play a crucial role in the monitoring and mitigation of heavy metal pollution through processes like bioaccumulation and phytoremediation. Among various plants, Nerium oleander (commonly known as oleander) is widely recognized for its ornamental value and its ability to thrive in polluted environments [1].
Oleander, native to the Mediterranean region, has been extensively studied for its potential in accumulating heavy metals. The plant is particularly interesting due to its widespread availability, tolerance to harsh environmental conditions, and the presence of different varieties, such as pink and white oleander, which may exhibit varying capacities for heavy metal accumulation. In Libya, where urbanization and industrial activities are expanding, studying the accumulation of heavy metals in oleander plants is of significant importance. This study aims to assess the concentration of heavy metals in pink and white oleander leaves collected from different locations in Libya, providing insights into the potential risks posed by environmental contamination and the suitability of oleander for phytoremediation efforts [2].
Several studies have focused on the ability of Nerium oleander to accumulate heavy metals, highlighting its potential as a bioindicator and a phytoremediation agent [1]. Conducted a comprehensive study on the accumulation of heavy metals in urban plants, including oleander, within polluted environments. Their findings indicate that oleander can significantly absorb heavy metals, making it a suitable plant for environmental monitoring. Wang and Zhang carried out a comparative analysis of heavy metal concentrations in ornamental plants, emphasizing Nerium oleander [2]. Their research revealed differences in metal accumulation between various plant species, with oleander showing a relatively high uptake capacity. Similarly, Ali assessed the heavy metal tolerance and accumulation in Nerium

oleander, suggesting that this plant could be effectively used for phytoremediation in contaminated areas [3]. Further studies by Kumar and Singh compared the heavy metal uptake and accumulation between pink and white varieties of Nerium oleander [4]. They found notable differences between the two varieties, with the pink variety generally accumulating higher concentrations of metals. Siddiqui reviewed the phytoremediation potential of Nerium oleander, underscoring its effectiveness in polluted soils and its resilience under adverse environmental conditions [5].
The bioaccumulation of heavy metals in oleander and their potential impacts on human health were explored by Gupta and Mishra, who highlighted the health risks associated with metal accumulation in plants grown in contaminated soils [6]. Barakat and Kumar provided an in-depth analysis of heavy metal contamination in soil and its subsequent accumulation in oleander plants, reinforcing the plant's role as a bioindicator [7]. Rasool and Jan examined heavy metal accumulation in different parts of oleander plants from industrial areas, finding that the leaves and roots were particularly effective in absorbing metals [8]. Chen and Liu conducted a comparative study on the uptake of heavy metals by different oleander species in urban areas, further establishing the plant's capacity for metal accumulation [9]. Finally, Sharma investigated heavy metal accumulation and tolerance in oleander plants from various geographical regions, providing a broader perspective on the plant's adaptability and its potential applications in different environmental contexts [10]. These studies collectively demonstrate the significance of Nerium oleander in heavy metal accumulation research and its potential utility in mitigating environmental contamination. The present study builds on this body of knowledge by specifically focusing on the concentration of heavy metals in pink and white oleander leaves in Libya, contributing valuable data to the ongoing efforts to understand and address environmental pollution in the region.

Material and Method

Sample collection

Pink and white oleander leaves were collected from the city of Sabratha for heavy metal analysis.

Research area

The analysis was conducted at the Oil Research Center in Tripoli. The tools used was; sensitive balance, crucible with lid, standard flasks (50 ml capacity), drying oven, convection furnace, pipette, pink and white oleander leaves, concentrated nitric acid, and distilled water.

Methodology

The collected samples were air-dried at room temperature for one week. About 1 gram of dried sample was placed in a pre-weighed crucible and then dried in an oven at 105°C for 24 hours. The crucible was then weighed with the sample to calculate the moisture content. The dried samples from the previous step were placed in a muffle furnace at 550°C for four hours. After cooling, the crucibles were weighed to determine the ash content.
The ash samples were transferred to a 50 ml standard flask, dissolved in a small amount of distilled water, followed by the addition of 5 ml of 2M nitric acid. The mixture was heated to 100°C until it began to boil. After cooling, the solution was diluted to the 50 ml mark with distilled water and filtered if necessary. Lead concentration was measured at the Libyan Oil Institute laboratories using an Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) following the EPA3050B method.
A primary standard series was prepared using a 99.99% pure element solution diluted with deionized water to concentrations of 10, 5, 1, and 0.1 ppm. The total volume was adjusted to 100 ml. Absorbance was measured at specific wavelengths for each element, and a standard curve was constructed to represent the relationship between concentration and absorbance. A blank digestion was performed using a zero-solution prepared in the same manner as the samples but without any actual sample.
The concentrations of the sample solutions were measured under the same conditions as the standard solutions. Each measurement was repeated three times, and the average readings were recorded.

Data analysis

Descriptive statistics such as frequency (%), mean and standard deviation were used to present the characteristics of the samples as appropriate. The results of the study and its characteristics were compared with the standard numbers of the analyses.

Results

Moisture Content

The moisture content in the samples was calculated using the following equation:

$$\text{Moisture content} \% = \frac{W1 - W2}{W1} \times 100$$

Where W1 represents the weight of the sample and W2 represents the weight of the dry sample. The results showed that the moisture content ranged between 11% and 14.8% in the white oleander samples and between 9% and 12% in the pink oleander samples (table 1 & figure 1).

Table 1. Moisture and Ash Content in White and Pink Oleander Samples

Sample	W1	W2	W3	Moisture Content %	Ash continent%
A1	1.006	0.293	0.1073	70.9	10.6
A2	1.071	0.9234	0.1174	14.8	10.9
A3	0.9884	0.8751	0.0952	11.3	9.6
A4	0.9993	0.8879	0.1012	11.1	10.1
A5	0.9962	0.8716	0.0936	12.5	9.3
A6	0.9934	0.8741	0.1236	12.0	12.4
A7	0.9999	0.8895	0.1196	11.0	12
A8	0.9986	0.8881	0.1173	11.0	11.7
B1	1.0021	0.9015	0.109	10	10.9
B2	1.0001	0.9094	0.107	9	10.7
B3	1.0015	0.8871	0.109	11.4	10.8
B4	1.0003	0.9000	0.105	10.3	10.5
B5	1.003	0.8818	0.093	12	9.3
B6	1.002	0.8880	0.099	11.4	9.9
B7	0.9983	0.8855	0.093	11.3	9.3
B8	1.008	0.8937	0.074	11.3	7.3

The ash content was calculated using the following equation:

$$\text{Ash content} \% = \frac{(W3 - W1)}{(W2 - W1)} \times 100$$

Where W3 represents the weight of the ash. $\text{Ash content}\% = \frac{(W_3 - W_1)}{(W_2 - W_1)} \times 100$

The results indicated that the ash content ranged between (9.3% and 12.4%) in the white oleander samples and between (7.3% and 10.9%) in the pink oleander samples.

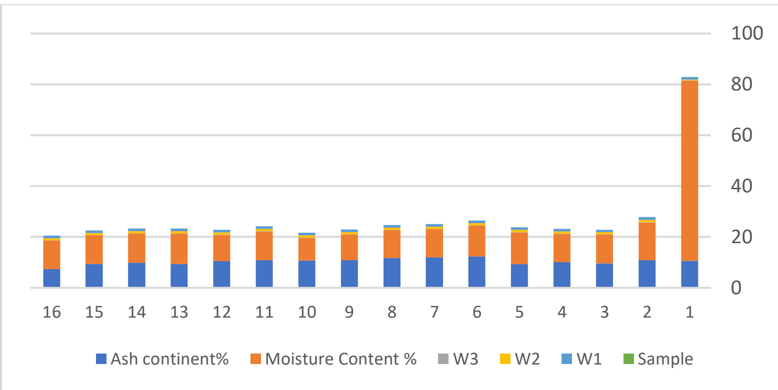

Figure 1. Moisture and Ash Content in White and Pink Oleander Samples

Concentrations of Heavy Metals
The concentrations of heavy metals in both white and pink oleander samples were analyzed (Table 2). Here are the summarized results:
- Manganese (Mn): In white oleander, concentrations ranged from (0.45 to 0.60 ppm). In pink oleander, the range was 0.32 to 0.68 ppm.
- Iron (Fe): Concentrations in white oleander ranged from (1.49 to 2.45 ppm). In pink oleander, they ranged from (1.05 to 2.20 ppm).
- Copper (Cu): The white oleander samples showed concentrations ranging from (0.07 to 0.10 ppm). In pink oleander, the range was (0.11 to 0.81 ppm).
- Boron (B): Concentrations in white oleander ranged from (3.04 to 7.89 ppm). In pink oleander, they ranged from (2.20 to 10.05 ppm).
- Arsenic (As): Both white and pink oleander samples showed concentrations ranging from (0.11 to 0.12 ppm).

Table 2. Concentrations of Heavy Metals (Mn, Fe, Cu, B, As)

Sample Ppm	As 188.980 nm	B 249.772 nm	Cu 327.395 nm	Fe 238.204 nm	Mn 257.610 nm
BK	0.11	3.46	0.04	0.25	0.00
A1	0.12	3.04	0.10	2.09	0.45
A2	0.11	7.45	0.08	1.88	0.53
A3	0.11	3.11	0.07	1.96	0.48
A4	0.12	7.55	0.08	2.44	0.45
A5	0.12	3.46	0.08	1.49	0.49
A6	0.11	7.89	0.07	2.45	0.60
A7	0.11	4.76	0.08	2.19	0.53
A8	0.12	4.20	0.07	1.76	0.56
B1	0.12	3.50	0.18	1.69	0.66
B2	0.12	6.44	0.81	2.20	0.62
B3	0.12	3.84	0.21	2.14	0.65
B4	0.11	5.44	0.12	1.05	0.32
B5	0.11	2.73	0.16	1.77	0.48
B6	0.12	6.41	0.15	1.83	0.68
B7	0.11	2.20	0.11	1.30	0.36
B8	0.12	2.45	0.18	1.86	0.53

A = oleander plant samples (white color), B = oleander specimens (pink color), BK = absorbance value of zero solution

Concentrations of heavy elements
For the other heavy metals, the result exhibited in table 3 shows the following;
- Cadmium (Cd): No detectable amounts were found in any samples.
- Vanadium (V): All samples showed a concentration of (0.01 ppm).
- Zinc (Zn): In white oleander, concentrations ranged from (0.12 to 0.70 ppm). In pink oleander, the range was (0.20 to 0.78 ppm).
- Strontium (Sr): The white oleander samples showed concentrations ranging from (13.18 to 19.80 ppm). In pink oleander, the range was (5.24 to 17.33 ppm).
- Lead (Pb): Both white and pink oleander samples showed concentrations ranging from (0.01 to 0.03 ppm.
- Molybdenum (Mo): The concentration in both white and pink oleander samples was consistent at (0.02 to 0.05 ppm).

Table 3. Concentrations of Heavy Metals (Cd, V, Zn, Sr, Pb, Mo)

Sample Ppm	Mo 202.032 nm	Pb 220.353 nm	Sr 407.771 nm	Zn 213.857 nm	V 292.401 nm	Cd 214.439 nm
BK	0.00	0.02	0.01	0.04	0.00	0.00
A1	0.02	0.02	13.66	0.70	0.01	0.00
A2	0.03	0.02	15.84	0.20	0.01	0.00
A3	0.03	0.01	13.18	0.13	0.01	0.00
A4	0.02	0.01	13.52	0.15	0.01	0.00
A5	0.03	0.01	13.27	0.16	0.01	0.00
A6	0.03	0.01	19.80	0.15	0.01	0.00
A7	0.03	0.01	17.23	0.15	0.01	0.00
A8	0.02	0.03	17.33	0.12	0.01	0.00
B1	0.02	0.02	10.01	0.38	0.01	0.00
B2	0.02	0.03	11.84	0.78	0.01	0.00
B3	0.02	0.03	10.05	0.41	0.01	0.00
B4	0.01	0.02	5.24	.20	0.00	0.00
B5	0.01	0.02	7.00	0.28	0.01	0.00
B6	0.02	0.03	10.27	0.34	0.01	0.00
B7	0.01	0.03	5.49	0.23	0.01	0.00
B8	0.05	0.02	7.09	0.38	0.01	0.00

Discussion

The results revealed that the concentrations of most heavy metals, including Mn, Fe, Cu, Zn, and Pb, in both white and pink oleander samples, were significantly below the WHO's permissible limits. This indicates that these metals do not pose any immediate health risks in the examined samples. For instance, Mn concentrations were found to be very low, ranging between 0.32 to 0.68 ppm, which is far below the WHO limit of 20-500 ppm. Similarly, Fe levels were also minimal, with a range of 1.05 to 2.45 ppm, well within the acceptable range of 50-250 ppm. These findings suggest that the environmental exposure to Mn and Fe through these plants is negligible, and there is no associated health risk.

The low levels of Cu, ranging from 0.07 to 0.81 ppm, further support the conclusion that oleander plants in the study area do not accumulate this metal to hazardous levels, remaining well within the WHO's recommended limit of 10 ppm. Similarly, Zn concentrations, which were observed to be mostly below 0.70 ppm, are significantly lower than the permissible range of 50-100 ppm, indicating minimal environmental and health concerns regarding Zn. However, the study did find slightly elevated levels of As in both oleander varieties, with concentrations ranging from 0.11 to 0.12 ppm, which exceed the WHO limit of 0.1 ppm. Although the excess is minor, it does suggest a potential need for further monitoring and investigation, especially since even small amounts of As can have toxic effects over time. This finding highlights the importance of continuous environmental monitoring to ensure that as levels do not increase to more concerning levels.

On the other hand, Sr concentrations, while relatively high (up to 19.80 ppm in white oleander), do not pose an immediate health risk. The WHO does not specify limits for Sr in plants, and the detected levels are within typical natural ranges. Nonetheless, the accumulation of Sr in these plants suggests a need for further research to better understand its environmental and health implications, especially in regions where Sr levels might be naturally higher.

Lastly, Pb concentrations were found to be consistently low, with levels below 0.03 ppm, which is far below the WHO's acceptable limit of 2 ppm. This suggests that Pb contamination is not a significant concern in these samples, and the plants are safe from a lead toxicity perspective.

Overall, the results indicate that, aside from the slight elevation in as levels, the heavy metal concentrations in the oleander samples are within safe limits as per WHO guidelines. This suggests that the oleander plants studied do not pose significant environmental or health risks in terms of heavy metal contamination. These findings are consistent with previous studies on Nerium oleander, reinforcing the plant's potential for safe growth even in environments with low to moderate heavy metal pollution.

Conclusion

The analysis of Nerium oleander samples from Sabratha city, Libya, revealed notable differences in heavy metal concentrations between the pink and white varieties. Most metal levels, including manganese, iron, copper, and zinc, were within WHO's permissible limits, indicating general safety. However, slightly elevated arsenic levels in both varieties raise concerns about potential toxicity, highlighting the need for ongoing monitoring. The study also found that white oleander had higher moisture and ash content compared to pink oleander, which may relate to differences in water and mineral absorption. White oleander showed higher iron concentrations, while pink oleander accumulated more manganese and displayed greater variability in copper levels. Boron levels were notably higher in certain white oleander samples, suggesting a propensity for boron accumulation. Lead and molybdenum concentrations were low across all samples, indicating minimal environmental pollution. Overall, while the oleander plants appear safe, the findings emphasize the importance of continuous monitoring, especially regarding arsenic, to ensure the plants' safety and environmental health. Regular monitoring of heavy metal concentrations in oleander plants in the Sabratha region is recommended to track changes over time and identify any potential environmental hazards.

References

1. Ahmad I, et al. Heavy metal accumulation in urban plants: A case study of Oleander (Nerium oleander L.) in polluted environments. Journal of Environmental Management. 2024;320: 115936.
2. Wang J, Zhang, X. Comparative analysis of heavy metal concentrations in ornamental plants: Focus on Nerium oleander. Environmental Pollution. 2023;310:119877.
3. Ali, H., et al. Assessment of heavy metal tolerance and accumulation in Nerium oleander: Implications for phytoremediation. Ecotoxicology and Environmental Safety. 2022;241: 113806.
4. Kumar R, Singh P. Heavy metal uptake and accumulation in Nerium oleander: A comparative study of pink and white varieties. Environmental Monitoring and Assessment. 2022;194:57.
5. Siddiqui M et al. Phytoremediation potential of Nerium oleander for heavy metal polluted soils: A review. Environmental Technology & Innovation. 2021;23:101684.
6. Gupta S, Mishra A. Bioaccumulation of heavy metals in Nerium oleander and their potential impacts on human health. Journal of Hazardous Materials, (2020). 396, 122649.
7. Barakat M, Kumar P. Analysis of heavy metal contamination in soil and its accumulation in Nerium oleander plants. Environmental Science and Pollution Research. 2020;27:12192-12203.
8. Rasool A, Jan R. Heavy metal accumulation in different plant parts of Nerium oleander from industrial areas. Journal of Plant Research. 2019;132(6):871-879.
9. Chen Y, Liu J. Comparative uptake of heavy metals by Oleander species in urban areas. Journal of Environmental Science and Health, Part A. 2019;54(8):700-710.
10. Sharma P, et al. Heavy metal accumulation and tolerance in Nerium oleander plants from different geographical regions. Environmental Geochemistry and Health. 2018;40(1):235-246.