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Toxicological Profiling of Heavy Metal Distribution in Poisonous Plants

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ABSTRACT

The present research deals with the analysis of heavy metal accumulation in toxic plants such as *Catharanthus roseus, Nerium oleander, Cascabela thevetia, Datura stramonium, and Calotropis gigantea*, using Energy Dispersive X-Ray Fluorescence (EDXRF) spectrometry. The different parts of the plants (leaves, stems, flowers, and fruits) were analyzed to find out the distribution and concentration of heavy metals like Fe, Cu, Mn, Cr, Zn, and Ba. The results showed a pattern of metal accumulation that was specific to the species and the plant tissue, with *Cascabela thevetia* and *Datura stramonium* being the most significant in terms of metal uptake capacity. These findings underscore the twin roles of toxic plants as monitors for pollution and as aids in forensic toxicology, especially in the area of distinguishing between natural plant toxicity and metal-induced poisoning. The study indicates the significance of elemental profiling for environmental monitoring and forensic purposes.

1. INTRODUCTION

Toxic plants will be plants that have in their constitution substance mixtures or dynamic standards, which through contact, inward breath or ingestion, are equipped for causing injury, illness and even demise in people and creatures. These mixtures might be alkaloids, glycosides, saponins, oxalates, tannins, among others. These mixtures are part of the optional metabolites of plants and despite the fact that they are viewed as poisonous to people and certain creatures, they have motivation to exist since they play significant jobs in safeguarding the plant against specific hunters and pathogens. The poisonousness of plants contrasts from one plant to another and relies upon a few variables, in particular the various synthetic compounds that describe it. The piece of the plant ingested, its fixation, the compound substances present, the age, the states of being for its turn of events (kind of soil, stickiness, temperature, season), and the maturing state of its natural products are perspectives to consider. In the event of inebriation, it means a lot to consider our own relational fluctuation, where attributes for example, age, weight, state of being and level of openness to the plant are key and once in a while determinant. Luckily, most poisonings are portrayed by disturbances of the gastrointestinal plot, like sickness, spewing, the runs and some dermatological uneasiness, like dermatitis. There are, be that as it may, more extreme poisonings in which cytotoxicity or focal sensory system sorrow can happen, which can prompt respiratory and heart disappointment, prompting demise. The most effective way to limit unplanned inebriation with harmful plants is to know about them. This information ought to be spread by the populace by and large, particularly to youth instructors and to true substances that do planning drawings of parks and gardens. In the event of unplanned ingestion, the rest of the plant ought to be eliminated from the mouth, which ought to be flushed with water. The plant should be put away for distinguishing proof so that the most proper treatment can be gotten. It is essential to abstain from instigating regurgitating, as it might cause blockage of the glottis and suffocation.

1.*Catharanthus roseus (L.)*

Eng: Madagascar periwinkle

Originally from Madagascar, this plant is now widely distributed over India's wastelands and gardens. This attractive annual herbaceous plant stands upright; its glossy, oval, oblong, or obovate leaves are deep green; white or deep rose-coloured flowers cluster in cymose axillary clusters; fruits, alkaloids, which are found throughout the entire plant but especially in the root bark, have sedative, hypotensive, and calming effects. It is a traditional treatment for diabetes. The root is used as a somatalgic and tonic and is poisonous, harsh, and caustic. The leaf juice has abortifacient and wasp-stinging properties. Certain types of leukaemia can benefit from the alkaloid vincristine, which is derived from this plant.

2.*Nerium oleander (L.)*

Eng: Indian Oleander, Sweet scented Oleander

Oleander, or Nerium oleander, is a highly toxic shrub with lovely flowers. The main toxins that cause acute cardiotoxicity are different cardiac glycosides found in all parts of the oleander plant. Even a trace amount of oleander can cause arrhythmia, dizziness, emesis, diarrhoea, and even death. The toxicity of N. Oleander has long been recognised. All parts of the plant contain cardiotoxic glycosides, but the seeds and roots are especially rich in them. Oleander contains two potent cardiac glycosides, or cardenolides, in every portion of the plant: neriine and oleandrin.

3.*Cascabela thevetia (L.)*

Eng: Lucky Nut, Mexican oleander, Yellow Oleander

It is regarded as useful in preparations for fever, leprosy, haemorrhoids, and eye infections, but it is toxic if taken alone. The deadliest cardenolides, thevetin A and thevetin B, are found in the seed and kernels, followed by leaves, fruit, and sap.4. Secondary metabolites include alkaloids, flavonoids, unsaturated steroids, triterpenoids, coumarins, phenols, essential oils, glycosides, terpenes, and tannins. The cardiac glycosides cause tremendous damage to the cardiovascular system (CVS) and abdomen by affecting the heart muscles and the autonomic nervous system (ANS).

4.*Datura stramonium*

Eng: Thorn apple, stinkweed, angel’s trumpet, and Jamestown weed

This kind of brain poisoning is vegetable deliriant. Datura stramonium is the botanical name. Typically, there are two types of plants: Datura nigra, which has purple or blackish blooms, and Datura alba, which has white flowers. Alkaloids such atropine, hyoscine (scopolamine), and hyoscyamine are the active ingredients. Only when seeds are chewed and ingested may poisoning occur. It tastes harsh and can initially cause higher brain regions to become stimulated. Respiratory paralysis causes death once the vital centers are depressed.

5.*Calotropis gigantea*

Eng: Giant Milkweed, Crown Flower, or Madar

It can result in what are known as “fabricated injuries,” which are skin lesions that resemble bruises and occasionally cause pustules and vesicles to emerge. When juice enters the eyes or comes into touch with them, it can cause acute conjunctivitis. The stem, branches, leaves, and the milky white latex (madar juice) are all toxic components. Uscharin, calotoxin, calotropin, and gigantin are significant poisonous principles. The plant has a bitter flavor. Burning pain in the throat, salivation, nausea, vomiting, and other symptoms are followed by diarrhea, abdominal discomfort, mydriasis, tetanic convulsions, delirium, collapse, and death.

Heavy metals in plants:

Relatively dense metals or metalloids that are known to have the potential to be hazardous, particularly in environmental settings, are considered heavy metals. The term "heavy metal toxicity" refers to an unnecessary or excessive concentration of naturally occurring metals that have been concentrated by human activity. These metals can enter plant, animal, and human tissues through inhalation, food, and manual handling, and they can attach to and disrupt essential cellular functions. Heavy metals were important environmental contaminants, and for ecological, evolutionary, nutritional, and environmental reasons, their toxicity is becoming a bigger issue .Copper (Cu), manganese (Mn), lead (Pb), cadmium (Cd), nickel (Ni), cobalt (Co), iron (Fe), zinc (Zn), chromium (Cr), iron (Fe), arsenic (As), silver (Ag), and platinum are among the metals and metalloids that have an atomic density greater than 4 g/cm3, or five times or more, than water. An organism's or a group of organisms' entire environment is referred to as their environment. This includes the various external physical conditions that impact and influence the organisms' growth, development, and survival. They are mostly found in rock formations in scattered form. Heavy metals were anthropogenically added to the biosphere by growing industrialization and urbanization, and they were most abundant in soil and aquatic environments, though in comparatively smaller amounts.

Objective of the study:

- To identify and analysis the presence of heavy metals present in toxic plants.
- To compare the heavy metal concentration in different parts (leaf, stem, flower, and fruit) of different toxic plants.

2.RESEARCH METHODOLOGY

Materials Required:

- Leaves, stem, flowers and fruit of *Catharanthus roseus, Nerium oleander, Cascabela thevetia, Datura stramonium, Calotropis gigantea*
- Agate Mortar and pestle
- Zip lock bags
- Distilled water

- Methanol
- Cotton

Sample Collection:

In the present study, five different plants such as *Catharanthus roseus, Nerium oleander, Cascabela thevetia, Datura stramonium* and *Calotropis gigantea* were subjected to analysis. The specimens were collected from the premises of Rashtriya Raksha University, Lavad, Gandhinagar, Gujarat during the month of March 2025.

Sample Preparation:

For preparing the sample for analysis,30 grams of various parts such as leaves, stem, fruit, and flowers were collected from random shrubs of *Catharanthus roseus, Nerium oleander*, *Cascabela thevetia, Datura stramonium and Calotropis gigantea* . The collected parts were then cleaned thrice with distilled water in order to remove contaminants and dust particles. The cleaned parts were dried under sunlight and weighed. Further, they were crushed using agate mortar and pestle and filtered using a clean sieve. The completely powdered samples were then stored separately with their sample names in sealed zip-lock bags to avoid contamination.

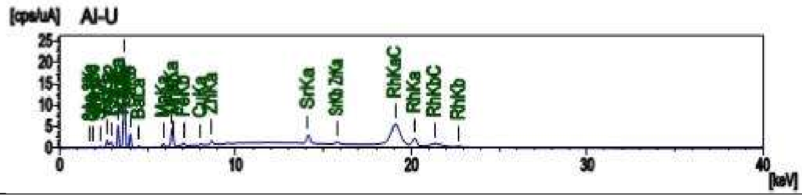
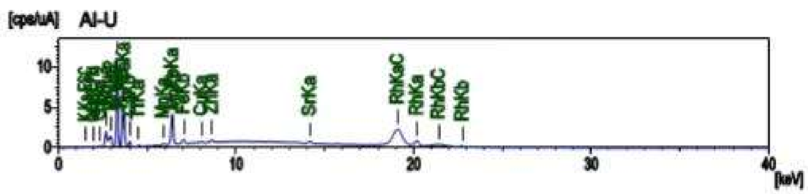
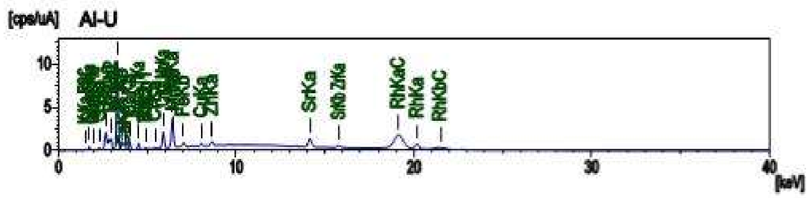
Sample Analysis:

The instrument used for the analysis is Energy Dispersive X-Ray Fluorescence (EDXRF) – 7000. Prior to the analysis, the instrument was calibrated using the software. All information regarding the sample was added to the software.2 grams of each sample were weighed using the analytical balance and kept in the sample holder and the detailed analysis was done. The sample holder was sterilised using methanol and cotton before the analysis of each sample.

3. RESULT AND DISCUSSION

The following graph shows the concentration of heavy metals in various parts of the chosen toxic plants. The graphical comparison shows how metals are found in leaves, stems, flowers, and fruits across species, pointing to species-specific accumulation and tissue-specific partitioning patterns. This representation shows the quantitative data that is used to emphasise the differential metal uptake and possible toxicological implication of each plant.

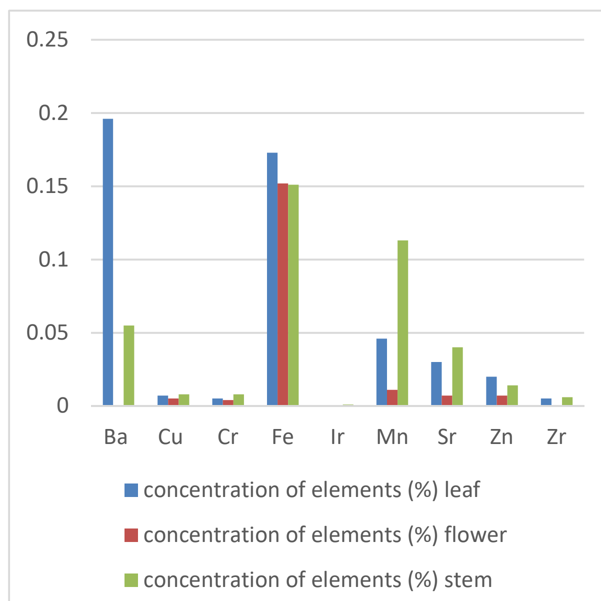
Sample 1: *Catharanthus roseus*

Leaf	
Flower	
Stem	

Graph 3.1: EDXRF Spectral Results for* Sample 1: *Catharanthus roseus

Element	Concentration (%)		
	Leaf	Flower	Stem
Ba	0.196		0.055
Cu	0.007	0.005	0.008
Cr	0.005	0.004	0.008
Fe	0.173	0.152	0.151
Ir			0.001
Mn	0.046	0.011	0.113
Sr	0.03	0.007	0.004
Zn	0.02	0.007	0.014
Zr	0.005		0.006

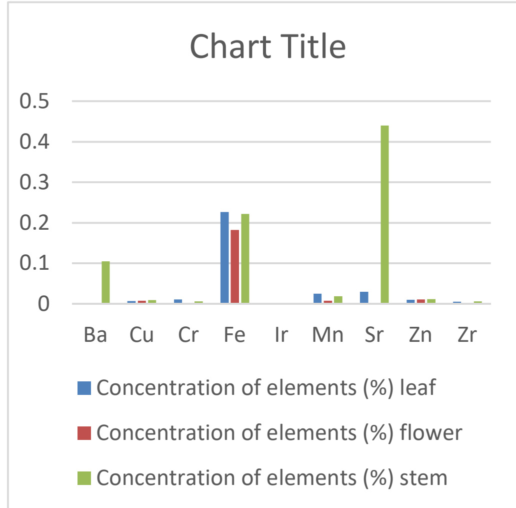
Table 3.1: Representing the percentage of heavy metals present in the *Catharanthus roseus* plant



Graph 3.1 Representing the concentration of heavy metals in the *Catharanthus roseus* plant

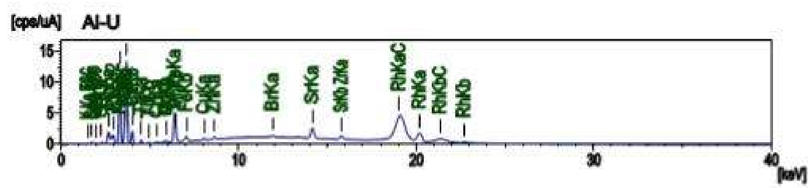
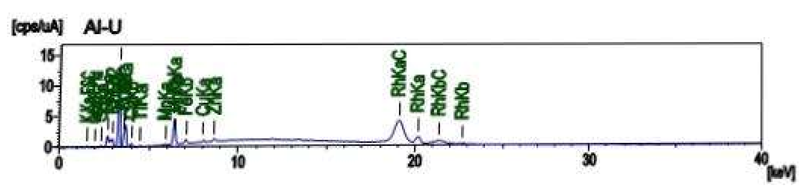
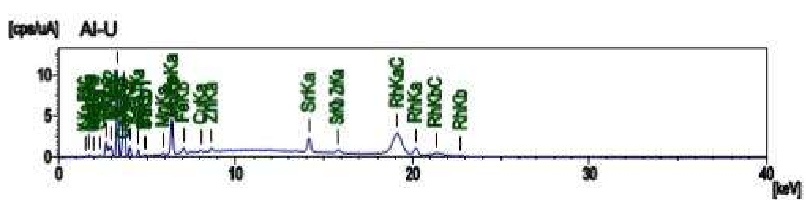
Element	Concentration (%)		
	Leaf	Flower	Stem
Ba			0.105
Cu	0.007	0.008	0.009
Cr	0.011	0.002	0.006
Fe	0.227	0.182	0.222
Ir	0.001		0.001
Mn	0.025	0.008	0.019
Sr	0.03		0.44
Zn	0.01	0.011	0.012
Zr	0.005		0.006

Table 3.2: Representing the percentage of heavy metals present in the *Nerium oleander*



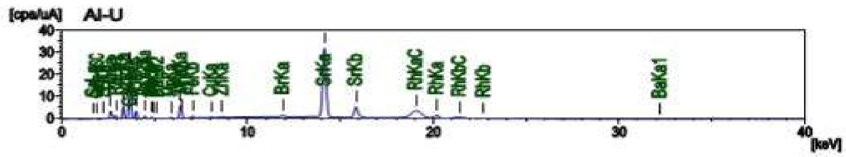
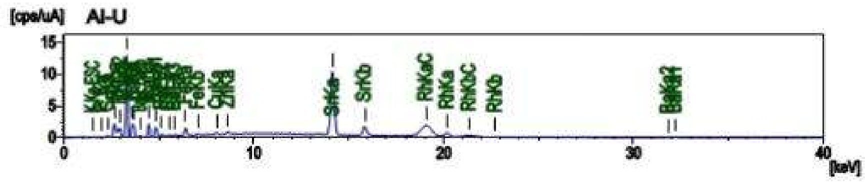
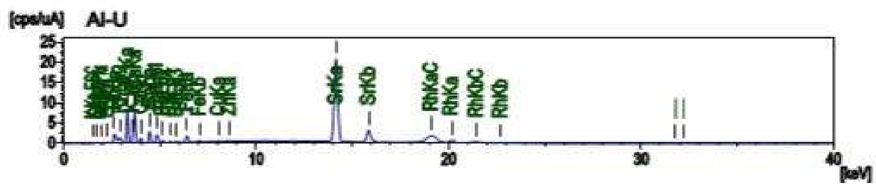
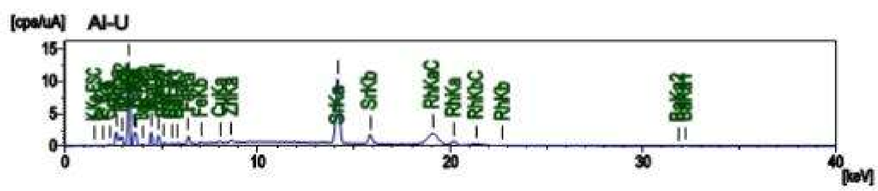
Graph 3.2 Representing the concentration of heavy metals in the *Nerium oleander* plant

Sample 2: *Nerium oleander*

Leaf	
Flower	
Stem	

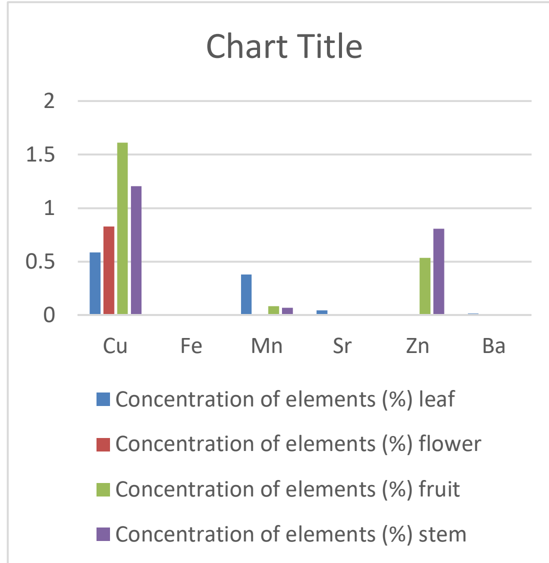
Graph 3.2: EDXRF Spectral Results for Sample 2: *Nerium oleander*

Sample 3: ***Cascabela thevetia***

Leaf	
Flower	
Stem	
Fruit	

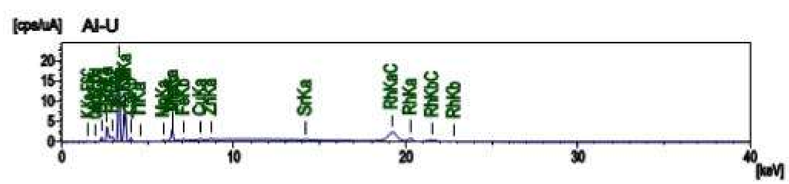
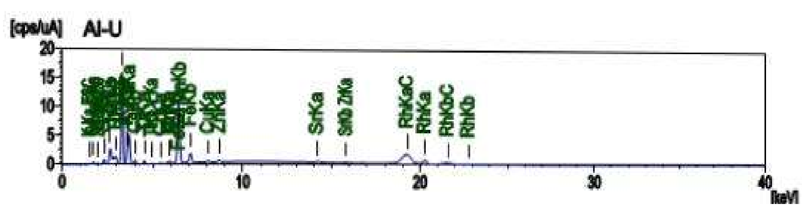
Element	Concentration (%)			
	Leaf	Flower	Stem	Fruit
Ba	0.015	0.007	0.01	0.005
Fe	0.01	0.007	0.009	0.007
Cu	0.587	0.83	1.612	1.204
Mn	0.38		0.085	0.07
Sr	0.046			
Zn			0.536	0.808

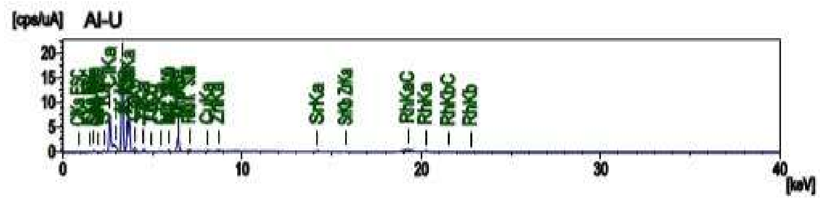
Table 3.3: Representing the percentage of heavy metals present in the *Cascabela thevetia* plant



Graph 3.1 Representing the concentration of heavy metals in the *Cascabela thevetia* plant

Sample 4: *Datura stramonium*

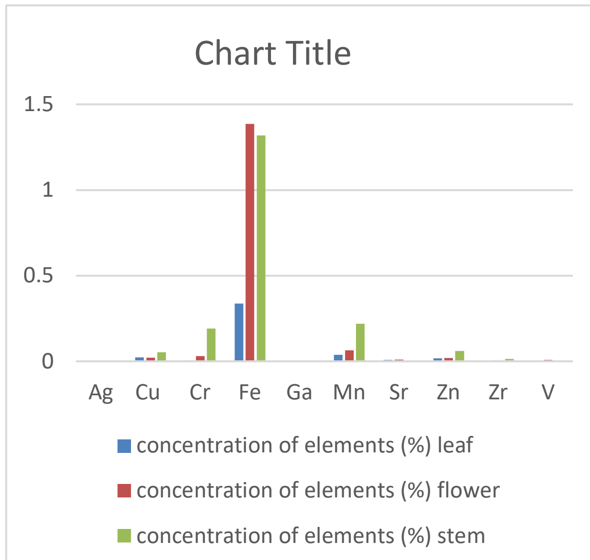
Leaf	
Flower	

Stem	

Graph 3.4: EDXRF Spectral Results for Sample 4: *Datura stramonium*

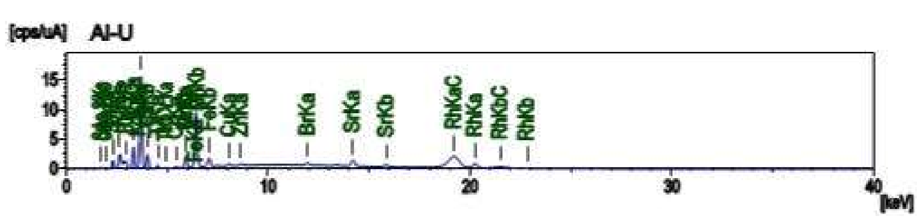
Element	Concentration (%)		
	Leaf	Flower	Stem
Fe	0.337	1.386	1.319
Mn	0.038	0.065	0.219
Cr	0.007	0.032	0.192
Zn	0.018	0.019	0.062
Cu	0.024	0.022	0.053
Ag	0.002		
V		0.008	
Sr	0.008	0.010	0.015
Zr		0.006	
Ga		0.001	0.003

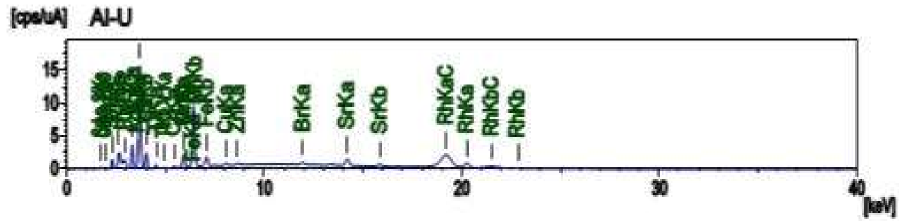
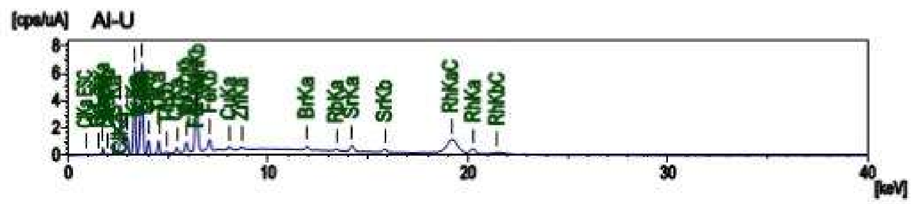
Table 3.4: Representing the percentage of heavy metals present in the *Datura stramonium* plant



Graph 3.4 Representing the concentration of heavy metals in the *Datura stramonium* plant

Sample 5: *Calotropis gigantea*

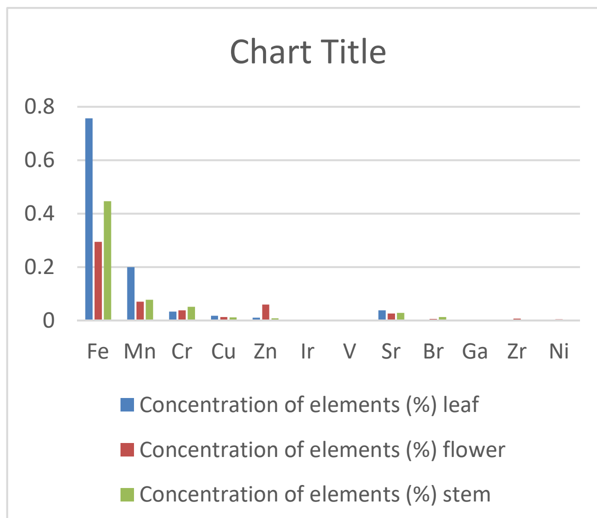
Leaf	

Flower	
Stem	

Graph 3.5: EDXRF Spectral Results for Sample 5: *Calotropis gigantea*

Element	Concentration (%)		
	Leaf	Flower	Stem
Fe	0.757	0.447	0.295
Mn	0.200	0.078	0.071
Cr	0.034	0.052	0.038
Cu	0.018	0.012	0.013
Zn	0.011	0.008	0.006
Ir	0.001		
V	0.004		
Sr	0.038	0.029	0.026
Br		0.013	0.006
Ga		0.013	
Zr			0.007
Ni			0.005

Table 3.5: Representing the percentage of heavy metals present in the *Calotropis gigantea* plant



Graph 3.5 Representing the concentration of heavy metals in the *Calotropis gigantea* plant

The five toxic plants examined exemplify varied strategies of heavy metal management, with *Cascabela thevetia* and *Datura* being outstanding accumulators, suggesting high phytoremediation potential; in particular*, C. thevetia* accumulates Copper (1.612%) and Iron (1.204%) predominantly in its stem, utilizing the tissue as a main sink for detoxification and immobilization, whereas *Datura* displays strictly specific hyper-accumulation of Gallium (1.092%) in the flower, a rare tactic indicating a distinct, defence-correlated metabolic function in the reproductive organs. On the other hand*, Calotropis* is inclined strongly to accumulate Iron (0.757%) and Manganese (0.2%) in leaves, probably dealing with metal toxicity through senescence of the leaves, while both *Nerium oleander* (stem Ba = 0.44%) *and Catharanthus roseus* (leaf Ba = 0.196%) exhibit high partitioning of non-essential Barium, collectively proving that these toxic plants use differential compartmentalization (stem vs. leaf) to counteract stress, thus making their inherent toxicity difficult with heavy inorganic element loads which requires care in their use since ancient times and defines their ecological function as bioindicators of metal-contaminated soil.

4.CONCLUSION

The toxicological profiling of *Catharanthus roseus, Nerium oleander, Cascabela thevetia, Datura stramonium,* and *Calotropis gigantea* indicates that all these species have different heavy metal accumulation patterns and tissue-specific compartmentalization. The co-existence of heavy metals along with bioactive substances like alkaloids and glycosides can enhance physiological toxicity, hence the plants are key contributors to accidental, suicidal, or homicidal poisoning incidents. Elemental profiling is a useful piece of evidence for source-to-victim or crime scene association and helps in the differentiation of natural toxicity from environmental pollution. Aside from their forensic significance, these plants also serve as bioindicators of metal-polluted environments, illustrating ecological adaptation to stressful conditions. Taken together, knowledge on their patterns of metal accumulation and synergistic interaction with phytochemicals further strengthens both toxicological analysis and forensic investigation, evincing their dual function in ecological monitoring and medico-legal applications.

5. REFERENCES

Ali, H., Khan, E., & Ilahi, I. (2019). Environmental chemistry and ecotoxicology of hazardous heavy metals: Environmental persistence, toxicity, and bioaccumulation. Journal of Chemistry, 2019, 6730305. https://doi.org/10.1155/2019/6730305

Bai, X., Wang, G., Ren, Y., & Han, J. (2019). Detection of highly poisonous plants and related toxic substances. In Fundamentals of Toxicology (pp. 295–312). Elsevier. https://doi.org/10.1016/B978-0-12-805426-0.00026-3

Brouwer, P., & Smith, R. (2018). Theory of X-ray fluorescence (XRF): Application to environmental analysis. Panalytical Press.

Gautam, R. K., Chandra, S., & Rani, R. (2016). Heavy metals in aquatic ecosystems: Toxicity and its impacts. In Environmental Science and Engineering (pp. 45–67). Springer.

Gupta, P. K. (2016). Toxic effects of poisonous plants. In Fundamentals of Toxicology (pp. 295–315). Academic Press.

Kabata-Pendias, A. (2011). Trace elements in soils and plants (4th ed.). CRC Press.

Khan, A., & Kazi, T. G. (2017). Determination of heavy metals in plants and soil using X-ray fluorescence spectrometry. Environmental Monitoring and Assessment, 189(6), 284. https://doi.org/10.1007/s10661-017-6004-2

Nouri, J., Khorasani, N., Lorestani, B., Karami, M., Hassani, A. H., & Yousefi, N. (2009). Accumulation of heavy metals in soil and uptake by plant species with phytoremediation potential. Environmental Earth Sciences, 59(2), 315–323. https://doi.org/10.1007/s12665-009-0028-2

Panda, S. K., & Choudhury, S. (2021). Forensic significance of toxic plants and heavy metal profiling. Forensic Science International, 327, 111197. https://doi.org/10.1016/j.forsciint.2021.111197

Panda, S. K., & Patra, H. K. (2018). Plant toxins and human poisoning: A biological overview. Toxicology Reports, 5, 1117–1132. https://doi.org/10.1016/j.toxrep.2018.11.010

Puri, B. K., & Haddon, M. E. (2018). Phytochemical and toxicological applications in forensic science. Forensic Chemistry, 10, 48–56. https://doi.org/10.1016/j.forc.2018.09.002

Rai, P. K., Lee, S. S., Zhang, M., Tsang, Y. F., & Kim, K. H. (2019). Heavy metals in food crops: Health risks, fate, mechanisms, and management. Environment International, 125, 365–385. https://doi.org/10.1016/j.envint.2019.01.067

Sharma, R. K., Agrawal, M., & Marshall, F. (2007). Heavy metal contamination of soil and vegetables in suburban areas of Varanasi, India. Ecotoxicology and Environmental Safety, 66(2), 258–266. https://doi.org/10.1016/j.ecoenv.2005.11.007

Sparks, D. L. (2020). Methods of soil analysis: Chemical methods (2nd ed.). Soil Science Society of America.

Tchounwou, P. B., Yedjou, C. G., Patlolla, A. K., & Sutton, D. J. (2012). Heavy metal toxicity and the environment. Experientia Supplementum, 101, 133–164. https://doi.org/10.1007/978-3-7643-8340-4_6

World Health Organization. (2020). Toxic plants and human health: Guidance for safe exposure. WHO Press.

Yoon, J., Cao, X., Zhou, Q., & Ma, L. Q. (2006). Accumulation of Pb, Cu, and Zn in native plants growing on a contaminated Florida site. Science of the Total Environment, 368(2–3), 456–464. https://doi.org/10.1016/j.scitotenv.2006.01.016