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Effect of industrial effluents on cytomorphological behaviour of medicinal plants *Withania somnifera* Dunal and *Achyranthes aspera* Linn

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ABSTRACT: Plants' capacity to accumulate metals is strongly influenced by the concentration of those metals in the soil. Physiological absorption, physicochemical desorption, and toxicodynamic redistribution are the three stages of the dynamic three-step process known as "availability". The soil's pH is the most influential factor in distributing metals between the solid phase and the soil solution. Worldwide, pollution and hazardous substance exposure are becoming more problematic. There is a serious threat to human health, plant life, and animal life due to the careless agricultural and industrial usage and disposal of hazardous compounds. Vehicle emissions, industrial smoke, and the leaching of chemical waste into groundwater and soil all contribute to the accumulation of heavy metals in the environment. The chemical makeup of industrial wastewater varies greatly. Determining which contaminants are present in effluents and how much of each is difficult and time-consuming. *Withania somnifera* Dunal and *Achyranthes aspera* linn, both found in water near an Indian industrial effluent site, have accumulated various heavy metals, contributing to the problem.

Keywords: Environmental pollution, heavy metal stress, BOD values, COD values.

INTRODUCTION

Soil metal content significantly impacts a plant's ability to acquire metals. There are three steps to the dynamic process known as "availability," which are physiological absorption, the thermodynamic process of desorption, and toxicodynamic redistribution. The soil's pH significantly impacts the ratio of metals in the solid phase to those in the soil solution. There is a growing crisis due to pollution and exposure to dangerous substances all throughout the world. Humans, plants, and animals are all in danger from the reckless use and disposal of toxic substances in agriculture and industry. The build-up of heavy metals in the environment results from several factors, including emissions from vehicles, industrial cigarettes, and the dissolution of hazardous materials into water and soil effluent. The Indian Ginseng, or Asgandh, is widely used as a tonic for the whole body, but it is most well-known for its erogenous zone benefits.

For this reason, it is often the central component in herbal blends. Although it is most usually utilised for its roots, this plant is beneficial for its many therapeutic applications (Sharma, 2013; Kirtikar and Basu 1935).

According to a recent study, most of Ghaziabad district's factories are located near the city's residential and farming communities. Despite the existence of the Pollution Control Acts, industrial waste is still being dumped into neighbouring streams and waterways through factory discharge channels. The region's pollution has devastated the development of several plant species with significant therapeutic potential. The growth and high quality of medicinal plants have suffered due to industrialisation. To this end, researchers in the district of Ghaziabad, Uttar Pradesh, and at the ALTT Centre in Ghaziabad compared the growth of the medicinal plant Achyranthes aspera Linn. in polluted Sahibabad and Trans Hindon Industrial areas with that in less-polluted Bayana and Dasana villages. Naaga Parpam and Naaga Chendooram, two "Siddha" preparations, use the plant as an ingredient. Seeds are rich in the chemicals alkaloid, oleanolic acid, saponin, hentriacontane, and achyranthine. The plant treats piles, boils, skin eruptions, and other similar conditions. Plant height, shoot length, root length, and leaves per plant were some of the measured and recorded growth variables in this research of industrial and controlled environments (Tyagi *et al.*, 2012).

Exceeding the safe threshold for heavy metals may disrupt metabolic processes. Thus, it may be detrimental to human health to either lack or have an abundance of critical micronutrients like Fe, Zn, and Cu. The interaction of dangerous metals (Cd, Cr, Pb, Ni, etc.) with vital trace elements may have detrimental effects on human health (Khan *et al.*, 2007). The World Health Organization suggests testing medicinal plants used in production for contamination with heavy metals, pesticides, germs, and fungi. Heavy metals' impacts on the environment and human health have been a significant cause for worry (Khan *et al.*, 2007).

Ocimum sanctum, *Cassia fistula*, *Withania somnifera*, and *Azadirachta indica* were all found to have very high Ca and Mg concentrations, whereas *Aloe barbadensis* had only slightly higher values (Maharia *et al.,* 2010). Exceeding the safe threshold for heavy metals may disrupt metabolic processes. According to H.R., Fathima, and Pai (2019), it is possible for both an insufficient amount of important micronutrients and an excessive amount of those nutrients to be detrimental to human health.

The accumulation of heavy metals in people's bodies over time makes their pollution very concerning. Metabolic disruption may occur when heavy metal levels exceed safe thresholds. Thus, deficiencies and excesses of necessary micronutrients (e.g., Fe, Zn, Cu) may have unintended consequences. In addition to potentially harmful effects on human health, interactions between toxic metals and necessary trace elements are also a concern. Cadmium, for instance, has been linked to both oesteomalica and pyelonephritis. Renal cancers and other carcinomas may also be caused by lead exposure. Although copper, iron, and zinc are mostly non-toxic, they become hazardous when concentrations exceed safe levels (Hussain and Khan 2010). As, Cd, and Cr levels were found to be excessive, whereas Cu, Pb, and Mn were found to be negligible. Over time, harmful metals have built up in agricultural land locations that have been continuously irrigated with wastewater (Atta *et al.,* 2023).

MATERIAL AND METHODS

Researchers gathered samples from the *Withania somnifera* Dunal plant with the *Achranthes aspera* linn from several locations in India close to industrial effluent sites. Dry weight analysis of the plants was also conducted, in addition to measuring their growth, germination days, stalk and leaf development length during a period of 2, 3, and 5 days at the location where the plants were developing in industrial waste effluent. The spectrophotometer with atomic absorption was then used to measure the concentrations of various metals in the two plants. Plant samples were collected from water bodies near an industrial area in India, where industrial effluent discharge was released and had an adverse effect on the growth, development, and cytomorphological properties of both *Withania somnifera* Dunal and *Achranthes aspera* linn. In addition, the BOD values for both of them species of plants were determined after the release of effluents and harmful material from the neighbouring industrial environment.

Formula used for calculating BOD demand= $BOD_n = [D_1 – D_n] / P$

Where,

D_1 = initial sample dissolved-oxygen (DO) concentration,

D_n = sample DO after 5 days,

P = Dilution factor (decimal volumetric fraction of sample used),

BOD_n = n^{th} day biochemical oxygen demand.

Formula for calculating the COD demand values = COD = [(A - B × N × 8 × 1000)] / Volume of sample taken

Where,

A = Volume of Ferrous Ammonium Sulphate for blank

B = Volume of Ferrous Ammonium Sulphate for sample

N = Normality of Ferrous Ammonium Sulphate

V = Volume of sample taken while conducting the experiment.

Estimation method for detecting the levels and concentration of the different heavy metals accumulated in the two plants being studied:

Researchers collected specimens from several lakes and rivers throughout India of the medicinal plants *Withania somnifera* and *Achranthes aspera* linn. The samples were washed twice, first with regular water and then with distilled water, before being dried in an oven at 60 degrees Centigrade and carefully placed in clean, dry polythene bags. Each dried sample was then ground to a powder using an agate vibratory disc mill and sieved with a 1.3 mm stainless steel mesh. The material was subjected to an oxidative treatment to extract the desired components. One gram of plant material was placed in a porcelain crucible and ignited in a muffle furnace at an elevation not exceeding 500 degrees Celsius for 24 hours to create dry ash. Before being broken down in a water bath for 20 minutes, the ashed sample was placed in a beaker containing water with 10 mL of 20% extremely pure grade HCl. The final product was filtered via a 0.8 m pore-diameter ultrafilter membrane. After adding enough deionized water to bring the filter up to 100 mL, it was put through a Perkin Elmer AAS under normal conditions for the quantitative measurement of Cr, Pb, Cu, Cd, Fe, Ni, and Mn.

RESULTS AND ANALYSIS

Table 1 gives an analysis of the levels of different heavy metals present in the two plants being studied in these experimental studies as given below. The plants shoot, root, development of fruits and formation of leaves gets affected due to the accumulation of the heavy metals from the effluents released from the nearby industries in the form of waste toxic material. Table 1 shows that there is a considerable deposition of heavy metals in the two plants being studied namely *Withania somnifera* Dunal and *Achranthes aspera* linn. Table 1 Shows the accumulation of different heavy metals in the plant *Withania somnifera* Dunal present in a water body around an industrial effluent site in India. The heavy metal concentration is given in units of mg/Kg. As evident from the values given in Table 1 the chromium heavy metal is highest in the soil, lead metal is highest in the stem part, copper is highest in the stem part, cadmium is highest in the root part, iron is highest in the leaf part and manganese is highest in the root part of the plant.

Table 2 gives the accumulation and the concentration of the heavy metal in the different regions of the plant *Achranthes aspera* linn.

According to the results given in Table 2 the highest concentration of chromium is found in the soil of the plant, lead is found in the highest amounts in the stem region, copper is found in the stem region in the highest amounts, cadmium is found in the highest amount in the root region, iron is found in the highest amount in the leaf of plant, nickel is found in the highest amount in the fruit of the plant and manganese is found in the highest amount in the root region of this plant.

Table 3 shows the values of BOD, COD, and colour of the plant sample, odour of the plant sample, and content of total dissolved matter and total suspended matter in mg/l for the study samples taken from different industrial effluent sites where the plants are growing. The BOD and COD values were calculated for the different industrial waste samples using the method of APHA, 1981 and Trivedi and Goel, 1986. The units of BOD and COD are mg/l.

Table 1.

Part of plant where the heavy metal is accumulated	Cr (mg/Kg)	Pb	Cu	Cd	Fe	Ni	Mn
Roots of plant	0.08	0.17	0.33	0.12	10.30	0.09	4.1
Stem region of plants	0.06	0.51	0.41	0.09	12.62	0.06	2.79
Fruit region of the plant	0.05	0.17	0.31	0.02	12.56	0.19	2.31
Soil in which the plant is growing	0.13	0.15	0.23	0.05	12.89	0.23	1.09
Leaves of the plant	0.06	0.05	0.17	0.03	14.76	0.04	4.52

Table 2.

Part of plant where the heavy metal is accumulated	Cr (mg/Kg)	Pb	Cu	Cd	Fe	Ni	Mn
Roots of plant	0.09	0.15	0.37	0.16	10.53	0.11	4.5
Stem region of plants	0.08	0.43	0.46	0.13	11.23	0.05	1.98
Fruit region of the plant	0.06	0.23	0.27	0.01	10.24	0.15	1.79
Soil in which the plant is growing	0.23	0.11	0.12	0.02	11.78	0.13	1.12
Leaves of the plant	0.03	0.06	0.19	0.02	12.56	0.02	4.01

Table 3.

Parameter characteristic	Effluent discharge sample from site 1	Effluent discharge sample from site 2	Effluent discharge sample from site 3	Effluent discharge sample from site 4	Permissible limit range of the samples
BOD (mg/l)	205	195	185	154	30
COD (mg/l)	850	724	657	554	250
Content of total dissolved solids	1200	1154	1057	1023	2000
Content of total suspended solids (mg/l)	250	240	210	196	500
Content of total solids (mg/l)	1450	1234	1124	1054	2500
pH	6.0	5.9	5.7	5.5	5.0-9.0
Colour	Yellow	Green	Brown	Black	Should be transparent
Odour	Foul smelling	Foul smelling	Pungent smelling	Pungent smelling	No smell

According to the results given in Table 3, the BOD value is highest for site 1, COD value is highest for site 1, and content of total suspended and total dissolved matter is highest for site 1.

The Table 4 shows the change in the growth of root and shoot of the plants *Withania somnifera* Dunal and *Achranthes aspera* linn before and after treating them with industrial effluents at varying concentrations. The treatment was given for a time period of different days like 2 days, 3 days and 5 days.

The results in Table 4 indicate that the growth of the shoot and roots in both the plants is highest in the water treated samples and the growth of the shoot and roots is lesser in the effluent treated plant samples at different concentrations. The length of the shoot and root is lesser as the day interval of the effluent treatment increases from 2nd day to 3rd day and finally till 5th day.

The technique of atomic absorption spectrophotometry was used to assess the build-up of heavy metals such as lead, copper, zinc, chromium, iron, and nickel in medicinal plant components such as roots, stems, leaves, and seeds. These heavy metals include Pb, Cu, Zn, Cr, Fe, and Ni. Locals treat a wide range of physical ailments with herbs, including Datura alba Nees, *Withania somnifera* L, *Alhagi pseudalhagi* Desv, and *Achyranthes aspera* L. Datura alba roots had the highest Pb levels among the four plant specimens tested, followed by *Achyranthes aspera* leaves and *Withania somnifera* roots. High levels of Cr, Fe, and Zn were detected in all of the specimens. This research aimed to examine the amounts of hazardous metals in plants often utilized by locals as herbal remedies (Hussain *et al.,* 2006).

Table 4.

***Withania somnifera* Dunal plant treatment**	**Treatment of the plants with normal water**	**Treatment of the plants with 10% concentration of industrial effluent discharge**	**Treatment of the plants with 30% concentration of industrial effluent discharge**	**Treatment of the plants with 70% concentration of industrial effluent discharge**	**Treatment of the plants with 100% concentration of industrial effluent discharge**
Length change in roots (cms)					
After 2 days	1.54 ± 0.24	0.38 ± 0.12	0.32 ± 0.13	0.24 ± 0.07	0.03 ± 0.02
After 3 days	1.83± 0.13	0.72 ± 0.14	0.69 ± 0.16	0.54 ± 0.17	0.02 ± 0.01
After 5 days	1.97 ± 0.24	1.17 ± 0.23	1.03 ± 0.21	0.91 ± 0.19	0.01 ± 0.01
Length change in shoots (cms)					
After 2 days	2.56 ± 0.15	0.31 ± 0.09	0.25 ± 0.05	0.16 ± 0.15	0.05 ± 0.11
After 3 days	2.76 ± 0.34	0.65 ± 0.15	0.53 ± 0.13	0.47 ± 0.16	0.03 ± 0.09
After 5 days	3.54 ± 0.67	0.98 ± 0.17	0.85 ± 0.17	0.78 ± 0.23	0.02 ± 0.05
***Achranthes aspera* linn plant treatment**	**Treatment of the plants with normal water**	**Treatment of the plants with 10% concentration of industrial effluent discharge**	**Treatment of the plants with 30% concentration of industrial effluent discharge**	**Treatment of the plants with 70% concentration of industrial effluent discharge**	**Treatment of the plants with 100% concentration of industrial effluent discharge**
Length change in roots (cms)					
After 2 days	1.44 ± 0.25	0.41 ± 0.14	0.35 ± 0.17	0.21 ± 0.06	0.03 ± 0.06
After 3 days	1.81± 0.15	0.65 ± 0.17	0.59 ± 0.21	0.41 ± 0.11	0.02 ± 0.11
After 5 days	1.91 ± 0.29	1.19 ± 0.29	1.09 ± 0.29	0.83 ± 0.11	0.01 ± 0.11
Length change in shoots (cms)					
After 2 days	2.21± 0.14	0.39 ± 0.13	0.21 ± 0.08	0.13 ± 0.23	0.06 ± 0.14
After 3 days	2.56 ± 0.38	0.69 ± 0.19	0.51 ± 0.17	0.40 ± 0.25	0.03 ± 0.11
After 5 days	3.45 ± 0.54	0.91 ± 0.15	0.81 ± 0.19	0.71 ± 0.29	0.01 ± 0.02


(a) *Withania somnifera* plant treated with 100% industrial effluent.


(b) *Withania somnifera* plant treated with 70% industrial effluent.


(c) *Withania somnifera* plant treated with 30% industrial effluent.


(a) *Achyranthes aspera* plant treated with 70% industrial effluent.


(b) *Achyranthes aspera* plant treated with 100% industrial effluent.


(c) *Achyranthes aspera* plant treated with 30% industrial effluent.

Several different plants native to Pakistan have been identified as having medicinal potential and are employed in the country's customary herbal medicine. In this work, the authors analyze the atomic mass spectrometry data for the first time to determine the trace (Zn, Cu, Cr, Ni, Co, Cd, Pb, Mn and Fe) and significant (K, Na, Ca and Mg) elemental composition of ten of the medicinal plants most commonly used (*Achyranthes aspera*, *Alternanthera pungens, Brassica campestris, Cannabis sativa, Convolvulus arven*. In addition, we include some essential details on heavy metal exposure. The worldwide safety criteria for consumption by humans indicate that the trace heavy metals content of all plants is high (Jabeen *et al.*, 2010), even though all plants collect substantial quantities of Fe, K, Na, Ca and Mg (Jabeen *et al*., 2010).

The analysis of these therapeutic plants found that they are rich in sodium, potassium, calcium, magnesium, and iron. However, in other instances, they have a very high level of dangerous metals, the primary cause of which is industrial contamination and the irrigation of contaminated wastewater. As a result, standard procedures for administering medicinal herbs need extra attention. Quality control procedures for screening herbal medications are also essential for consumer safety (Jabeen *et al.*, 2010). Pb content was found to be among the lowest of the hazardous heavy metals examined (Dado, 2023) in all of the plants sampled. Heavy metals (HMs) are now a common ingredient in herbal treatments, leading to widespread poisoning. Herbal medicine components derived from agricultural, industrial, or natural sources may include anthropogenic microorganisms (HMs). There is evidence that pollutants were intentionally introduced with the idea that they had a medicinal advantage in specific ethnic groups (Vinogradova *et al.*, 2023). Large, healthy seeds of the chosen plant were gathered from the designated regions and then sterilized in a 0.1% $HgCl_2$ solution for 10 minutes before being used in the germination trials. Five replicas of the soil were maintained wet with 25%, 50%, and 100% of the effluent of a chosen industry, as well as a control group (which was treated with ordinary water) for light germination. Root and shoot lengths and fresh and dry weights were measured on days 5, 7, and 9 (Sharma, 2013).

DISCUSSION

Ashwagandha, or *Withania somnifera* L. Dunal, is an essential Indian medicinal herb used worldwide to treat various conditions. This article will examine its botanical origins, photochemistry, and recent pharmaceutical developments. At least 62 essential and 48 less critical primary and secondary metabolites have been identified in *W. somnifera* leaves; of these, 29 are primarily steroidal chemicals, steroidal lactones, alkaloids, amino acids, etc., and are found both in the roots and the leaves. Anti-leukotriene, antineoplastic, painkillers, anti-oxidant, immunostimulatory, and rejuvenate qualities are only some of the many therapeutic activities discovered in the shrub's whole, most of which are shown in vitro. However, the future of its use in medicine has yet to be found. For future mechanism studies and possible medical benefits of *W. somnifera*, along with establishing a rational system for quality control for *W. somnifera* as a beneficial material, this review provides a thorough understanding of the genus and its constituents (Gaurav *et al.*, 2023).

Achyranthes aspera, a common weed in India, is essential for traditional medicine due to its therapeutic properties. The plant contains various phytochemical compounds, including antiperiodic, diuretic, purgative, laxative, antiasthmatic, hepatoprotective, and anti-allergic effects. It is used as a moderate astringent for digestive issues, and crushed for pneumonia. Early-stage diarrhoea and dysentery can be treated with powdered leaves, honey, or sugar sweets. Studies have shown the biological activity and pharmacology of its preparations, with various chemical components extracted, including saponins, oleonolic acid, dihydroxy ketones, alkaloids, and long-chain chemicals (Srivastav *et al.*, 2011).

CONCLUSION

The current investigation shows that the effluent from all sectors negatively impacts plant development owing to toxicity after heavy metal build-up. The wastewater from these factories should not be utilised for irrigation under any circumstances. Furthermore, effluents should be appropriately treated or reused for being disposed of and medicinal plants growing in the area of these companies should not be utilised to create medicines.

FUTURE SCOPE

Conducting extended monitoring studies to assess how the accumulation of heavy metals changes over time, considering seasonal variations and potential alterations in industrial processes.

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Conflict of Interest. None.

REFERENCES

Atta, M. I., Zehra, S. S., Dai, D. Q., Ali, H., Naveed, K., Ali, I., ... & Abdel-Hameed, U. K. (2023). Amassing of heavy metals in soils, vegetables and crop plants irrigated with wastewater: Health risk assessment of heavy metals in Dera Ghazi Khan, Punjab, Pakistan. *Frontiers in plant science*, *13*, 1080635.

Chandra, R., Kumar, K., & Singh, J. (2004). Impact of anaerobically treated and untreated (raw) distillery effluent irrigation on soil microflora, growth, total chlorophyll and protein contents of Phaseolus aureus L. *Journal of Environmental Biology*, *25*(4), 381-385.

Dado, T. B. (2023). Determination of levels of heavy metals in some selected traditional medicinal plants in Southern Ethiopia. In *AIP Conference Proceedings* (Vol. 2679, No. 1). AIP Publishing.

Gaurav, H., Yadav, D., Maurya, A., Yadav, H., Yadav, R., Shukla, A. C., ... & Palazon, J. (2023). Biodiversity, Biochemical Profiling, and Pharmaco-Commercial Applications of *Withania somnifera*: A Review. *Molecules*, *28*(3), 1208.

Hussain, I., & Khan, L. (2010). Comparative study on heavy metal contents in Taraxacum Officinale. *International Journal of Pharmacognosy and Phytochemical Research*, *2*(1), 15-18.

Hussain, I., Khan, F., Khan, I. U. and Ulah, W. (2006). Determination of heavy metals in medicinal plants. *Journal of the chemical society of Pakistan, 28*(4), 347-351.

Jabeen, S., Shah, M. T., Khan, S., & Hayat, M. Q. (2010). Determination of major and trace elements in ten important folk therapeutic plants of Haripur basin, Pakistan. *Journal of Medicinal Plants Research*, *4*(7), 559-566.

Khan, M. A., Ahmad, I. and Rahman, I. U. (2007). Effect of Environmental Pollution on Heavy Metals Content of *Withania somnifera*. *Journal of the Chinese Chemical Society, 54*(2), 339–343.

Kirtikar, K. R. and Basu, B. D., (1935). Indian Medicinal Plants, Vol. *2* and 3 Panini Office, Bahadurganj, Allahabad.

Maharia, R. S., Raj Kumar Dutta, Acharya, R. and Reddy, R. (2010). Heavy metal bioaccumulation in selected medicinal plants collected from Khetri copper mines and comparison with those collected from fertile soil in Haridwar, India. *J Environ Sci Health B, 45*(2), pp.174–181.

Sharma, S. (2013). Effect of Dabur India Limited effluent on physiological and biochemical parameters of *Withania somnifera* Dunal. *International Journal for Environmental Rehabilitation and Conservation*, *63*.

Srivastav, S., Singh, P., Mishra, G., Jha, K. and Khosa, R. (2011). *Achyranthes aspera*-An important medicinal plant: A review. *J. Nat. Prod. Plant Resour*, *1*(1), pp.1–14.

Tyagi, K., Sharma, S., Rashmi, R. and Ayub, S. (2012). Growth Study of Achyranthes aspera Linn. Under the Impact of Industrial Effluents. *Hippocratic Journal of Unani Medicine*, *7*(1), 99-107.

Vinogradova, N. A., А.И. Глухов, Chaplygin, V., Kumar, P., Saglara Mandzhieva, Minkina, T. and Rajput, V. D. (2023). The Content of Heavy Metals in Medicinal Plants in Various Environmental Conditions: A Review. *Horticulturae, 9*(2), 239–239.

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