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Arachis Pintoi (Mani-Manian) Leaves: A Phytoremediation Potential for Lead Contaminated Water

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Abstract:

Heavy metals, such as lead, are among the most toxic pollutants, posing a threat to all living things. With the development of industrialization and urbanization, the abundance of heavy metals in the environment has increased enormously raising significant concerns to the availability and quality of water sources in many areas worldwide. Hence, this study primarily aimed to perform an experiment that can determine if *Arachis pintoi* exhibits phytoremediation properties such as the ability to absorb heavy metals like lead and clean polluted wastewater. Based on the findings on the study, *Arachis Pintoi* has a phytoremediation potential to clean-up lead contaminated water. It highlights the efficiency and efficacy of phytoremediation as one innovative clean-up method that is less harmful to the environment, cost-effective, and that are more suitable for hospitality and tourism industry

Keywords — **Arachis Pintoi, Contaminated Water, Efficacy, Hospitality and Tourism Industry, Lead**

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I. INTRODUCTION

Water is essential to all. In hotel and tourism industry water plays a significant role for food preparation, cleaning and hygiene specifically for guest comfort and recreation. Water is a key resource in tourism and services to tourist are heavily dependent on it. Water can become constraint to sustainable development, a limit on tourist activities and an issue to conflict with local residents over allocation and pricing, in particular when water is a scarce resource. Thus, tourism and hospitality management ensure that the supply of water are safe for all negative elements such as lead.

Lead contaminated water is harmful to health especially for children. Lead can enter drinking water when plumbing materials contain lead corrode where the water has high acidity or low mineral content that corrodes pipes and fixture (Mulvihill, 2023).

Lead is a crucial toxic metal. It either reaches water system through urban run off or discharges such as sewage treatment plants and industrial plants. Lead is a chemical element represented by the symbol Pb with an atomic number of 82. It is a malleable and soft metal with a relatively low melting point. Heavy metals, such as lead, are among the most toxic pollutants, posing a threat to all living things and affects almost every organ and system in the human body whether swallowed or inhaled. Exposure to high levels of lead may cause anemia, weakness, cardiovascular effects, decreased kidney functions, reproductive problems, hearing loss, brain damage, and can even cause death.

With the development of industrialization and urbanization, the abundance of heavy metals in the environment has increased enormously during the past decades, which raised significant concerns

throughout the world. Since lead mining and smelting, as well as battery production, disposal, and recycling, are widespread in many countries, lead poisoning is a worldwide problem.

Hence, it is necessary to take remediation measures to prevent heavy metals from entering into terrestrial, atmospheric, and aquatic environments. This remediation or alternatives in the form of phytoremediation.

Phytoremediation is an emerging, low-cost, sustainable, and environmentally sound technology that uses plants and associated microorganisms to clean up pollution of soil, water, and the atmosphere (N. Dickinson, 2017). It is an attractive alternative to the current clean-up methods that are very expensive. Phytoremediation primarily addresses toxic heavy metals and chemical contaminants. However, due to the great diversity of flora, further research is needed in order to evaluate and select plant species with potential for wastewater treatment.

Arachis pintoi, commonly known as Mani-manian in Tagalog and belongs to the family of Fabaceae, is a forage plant growing about 8 inches high particularly in low-lying areas that are wet or flooded during the rainy season. It prefers soils with moderate to high fertility, but it can also withstand infertile soils and four-month dry seasons. Seedlings develop quickly, reaching ground cover spread by 6 months through its system of stolons. Stems of *A. pintoi* grow along the ground and root at the nodes. Each of its petiole has four oval leaflets. This plant bears yellow flowers down into the soil. Antioxidant, anthelmintic, and phyto-remediative properties have been suggested in studies. In the Philippines, it is used for free range kabir chickens, horses, pigs, tilapia, catfish, goats and cows and traditionally planted as ornamental landscaping ground cover.

Statement of the Problem

The study aims to analyse the phytoremediation of A. pintoi (Mani- manian) as a potential plant to absorb heavy metals like lead and clean polluted water.

Specifically it answer the following questions:

1. What are the phytoremediation properties of *A. pintoi* leaves?
2. Do *A. pintoi* leaves could be used as phytoremediation to clean up polluted water with lead?
3. What is the level of efficacy of *A.pintoi* leaves to clean-up water contaminated with lead?
4. Is *A.Pintoi leaves* used as alternative solutions to help hospitality and tourism industry as preventive measures to ensure safety water supplies?

Conceptual Framework

The conceptual framework of the study were based on several studies and literatures about phytoremediation of *A. Pintoi* leaves as potential for clean –up lead contaminated water especially used for hospitality and tourism industry.

According to Shackira et al. (2021) further conclude that phycoremediation, phytoremediation, and nano-phytoremediation thus represent promising tools for decontaminating and restoring the ecosystem in a sustainable manner without causing much harm to the biodiversity.

Figure 1 shows the conceptual framework of the study.

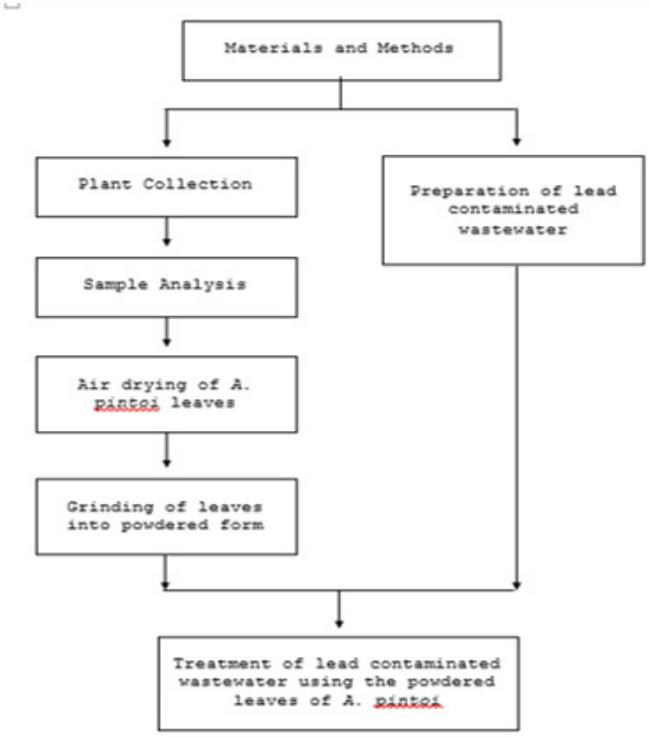

Fig. 1 Research Paradigm

II. METHODOLOGY

A. Methods

This study were utilized experimental and contextual research design in order to meet the objectives of the study. The materials to be used would be subjected to experiment and observation of the process to be used.

B. Collection of Arachis pintoi leaves

The leaves of Aracis pintoi would be obtained from Portana's residence at Poblacion Centro, Aliaga, Nueva Ecija.

C. Preparation of Plant Sample

The newly harvested leaves of Arachis pintoi will be washed two (2) times with clean water to remove foreign materials and will dried in air for fourteen (14) days. Afterwards, the samples was ground into powdered form.

D. Sources

Water samples would be obtained from Thermo Scientific Barnstead Nanopure Water Purification System of Tuklas Lunas Development Center. The lead solution wold be from the research specialist at Central Luzon State University, Science City of Muñoz, Nueva Ecija.

E. Preparation of Lead-Contaminated Wastewater

The experiment involves the mixture of lead solution and distilled water, which would served as a sample of contaminated wastewater. This procedure was conducted in a separate room at a Laboratory to avoid the contact of hazardous chemical.

Distilled water is preferable for use in laboratory experiments because it is free of contaminants such dissolved ions. Unlike tap water, which contains such impurities that can interfere with the chemical test via side reactions. Distilled water, obtained from the condensation of steam, is of better quality because distillation eliminates all of the sediment and most of the inorganic solutes. (Sharma and Bhattacharya, 2016)

F. Treatment of Lead-Contaminated Wastewater using Arachis pintoi leaves

The powdered form of *Arachis pintoi* leaves was placed in the sample of lead-contaminated wastewater. This would be done to determine if *A. pintoi* exhibits phytoremediation potential to clean wastewater that has been contaminated with lead.

A recent study of Chen et al. (2016) reported the effectiveness of the root powder of long-root *Eichhornia crassipes*, as a new kind of biodegradable adsorbent and has been tested for aqueous adsorption of Pb, Zn, Cu, and Cd. This study further established the efficacy of using powdered plants to remove pollutants or heavy metals from contaminated water.

G. Sample Analysis

The samples would be sent to the Department of Chemistry in Central Luzon State University for the heavy metal analysis using the MP-AES (Microwave Plasma Atomic Emission Spectroscopy)

The MP-AES (Microwave Plasma Atomic Emission Spectroscopy) describes a number of analytical techniques used to determine the elemental composition of a sample by examining its electromagnetic spectrum or its mass spectrum. This analysis has been used to determine the concentration of heavy metals or elements present in water, soil, and many other specimens.

H. Waste Disposal

The used laboratory equipment were washed and sanitized thoroughly. Materials that are contaminated with lead was also be disposed properly.

I. Ethical Consideration

Lead is a highly toxic chemical that may be harmful to organisms and the environment. Working with this chemical requires the assistance of scientists or professionals, as well as a suitable laboratory and equipment to be used. The researchers were required to take protective measures in performing tests and experiments. Moreover, the researchers ensure that no harm will

be done throughout the entire research process. They are also certain that any type of misleading information, as well as representation of primary data findings in a biased way were avoided.

J. Scope and Delimitation

This part presents the coverage and limitations of the study. The study considers only the phytoremediation potential of *A. Pintoi* as alternatives to cleaned-up polluted and lead contaminated water specifically in hospitality and tourism industry.

III. RESULTS AND DISCUSSIONS

K. Phytoremediation properties of A. pintoi leaves

In this study, the samples were analyzed for pH and lead concentration using Inductively Couple Plasma (ICP) before *Arachis pintoi* was planted. To evaluate the plants' capacity and tolerance for contaminated water, measurements of their height and Pb content were taken. After 90 days, the water samples were examined to determine the concentration level of lead.

L. Title and Author Details

Title must be in 24 pt Regular font. Author name must be in 11 pt Regular font. Author affiliation must be in 10 pt Italic. Email address must be in 9 pt Courier Regular font.

TABLE I
CONCENTRATION OF LEAD IN WATER SAMPLES WITH CORRESPONDING

Treatments	Number of Days	Lead Concentration
Control	0	13.3
CA 25%	15	13.09
CA 50%	30	14.56
CA 75%	60	14.46
CA 100%	90	11.87

Source: Patana et al. (2015)

The results of Lead accumulation in plant tissues were evaluated using Bioaccumulation factor (BF) to study the potential of plants for phytoremediation.

As shown in table, the concentration of Lead in water samples after 15, 30, 60, and 90 days. The findings reported that *Arachis pintoi* can uptake heavy metal from water and has the ability to grow in water contaminated with Lead. After planting for 90 days, the plant could remediate Lead up to 11.87%.

TABLE III
BIOACCUMULATION FACTOR (BF) OF LEAD IN PARTS OF PLANT TISSUES

Treatments	BF Values	
	Leaf	Shoot
Control	1.94	0.48
CA 25%	1.42	0.30
CA 50%	1.10	0.23
CA 75%	1.24	0.31
CA 100%	0.81	0.36

Source: Patana et al. (2015)

Table 2 presents the Bioaccumulation Factor (BF) Of Lead in leaf and shoot parts of plant tissues. The BF is defined as the ratio between the metal concentration in the plant tissue per that in the water. This is used to evaluate bioavailability for heavy metal accumulation in plants. The plant part that has BF value more than 1 is evaluated for heavy metal accumulation efficiency in plants and called Hyperaccumulator.

A hyperaccumulator is a plant capable of growing in soil or water with very high concentrations of metals, absorbing these metals through their roots, and concentrating extremely high levels of metals in their tissues (Rascio and Navari-Izzo, 2013).

Arachis pintoi Krap. & Greg. was able to survive when it was planted in water contaminated with coal-ash and has the ability to remediate water contaminated with heavy metals from coal dumping site (Patana et al., 2015).

In line with the findings of Patana et al. (2015), the researchers further conclude that *Arachis pintoi*, particularly its leaves, exhibit phytoremediation properties and provide a

promising treatment option for lead contaminated wastewater. This study serves as a foundation that supports the claim of the current research being presented.

IV. CONCLUSIONS

Today, although the strategic importance of freshwater is universally recognized more than ever before, water sources seem to face severe quantitative and qualitative threats. Heavy metals, such as lead, are among the most toxic pollutants, posing a threat to all living things. The study found out that *Arachis pintoi* exhibits phytoremediation properties such as the ability to absorb heavy metals like lead and clean polluted water. It also demonstrating its potential as a promising treatment option to address today's severe quantitative and qualitative threats to water sources.

Furthermore, the researchers claim that the powdered leaves of *A. pintoi* has the ability to accumulate heavy metals and clean polluted water that has been contaminated with Lead. This further implies the broad potential of *A. pintoi* in the field of Biotechnology.

Although there are currently numerous methods for treatment of contaminated water with heavy metals, this study also highlights the efficiency and efficacy of phytoremediation as one innovative clean-up method that is less harmful to the environment, cost-effective, and that are more suitable for hospitality and tourism industry.

Recommendations

The following recommendations are given following the completion of this study, based on the conclusions reached after reviewing the collected data and information.

This study focused mainly on the potential phytoremediation properties of *Arachis pintoi*, hence, the researchers recommend conducting further studies to discover other phytochemical properties of the examined plant and explore its uses in different fields such as in medicine and biotechnology.

They may also contribute further studies using other parts of the plant such as its roots and shoots.

Furthermore, the researchers also suggest producing a product in a different formulation to determine other potential phytoremediation activity of *A. pintoi*.

And it is also suggested for the future researchers to use other kinds of heavy metals such Cadmium and Arsenic to could help every individual to protect health to ensure for a safe water supply system/resources.

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