# **SWAMP CABBAGE** (*Ipomoea aquatica Forsk*) **as PHYTOREMEDIATOR of LEAD**

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# APPROVAL PAGE

This research paper hereto entitled:

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## Abstract


This study tested the potential of swamp cabbage (*Ipomoea aquatica Forsk*) as a phytoremediator of lead. It specifically determined the amount of lead in water, roots and stem of swap cabbage before and after phytoremediation after being exposed in ten days. It further determined the significant differences in the amount of lead in water, roots and stem of swamp cabbage before and after such process.

Artificial lead contaminants were placed in five sampling culture vessels each containing four litters of ground water. Each culture vessel contained five replicates. The plants were placed in the culture vessel and were set to be exposed to the lead contaminant in a duration of ten days. On the tenth day, the replicates were removed and were macerated. The lead content present in the extracts were measured using the lead iode probe.

Results showed that there was no significant difference in the amount of lead before and after the ten-day phytoremediation process.

## AKNOWLEDGEMENT

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To Engr. Ms. Resa Joyce V. Yandog, for rendering your time when we looked-for the concepts in organizing the methodology of our study and the information important to be considered in our research.

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# INTRODUCTON

## A. Background of the Study

The problem in Hanahan, South Carolina quiet suburb of Charleston, was not particularly unusual. In 1975, a massive leak from a military fuel storage facility released about 80,000 gallons of kerosene-based jet fuel(cluin.org). Immediate and extensive recovery measures managed to contain the spill, but could not prevent some fuel from soaking into the sandy soil. Ground water began leaching such toxic chemicals as benzene from fuel saturated soils and carrying them toward a nearby residential area(cluin.org). in the last 20 years much progress has been made in the cleanup of contaminated soils, sediments and groundwaters; but existing methods have proven to be very costly or limited in various ways. It is clear that cleanup of remaining sites with existing technologies will continue to be very expensive. It is partly for this reasons that there is a renewed interest in the cost-benefit ratio of these expenditures. Risk analysis may provide a basis for some sites to go unremediated, but uncertainties in the nascent science of risk analysis foster a public and scientific uneasiness. In the '90s a new technology, phytoremediation, the use of plants to remediate environmental toxicity was introduced. Plants are robust and solar powered. Their roots permeate the soil and sediment environments with an extensive and active membrane system(Miller 1995). Plant-based systems are welcomed by the public due to their superior aesthetics and the societal and environmental benefits that their presence provides(Miller 1995).

Phytoremediation is beneficiary for some reasons(bc4weeds.edu). The land that is being phytoremediated is hardly altered(bc4weeds.edu). Plants can be harvested and planted until the level of contaminants are down(bc4weeds.edu). The plants can be recycled and the metals can be removed through a process called digestion(bc4weeds.edu).

Plants that perform phytoremediation are called hyperaccumulators(becnet.org). The ideal hyperaccumulator for phytoremediation is a plant that can tolerate and accumulate the contaminates of interest(becnet.org). Agricultural scientists focus mainly on plants which are water-based or floating plants. These plants such as water hyacinth and water lettuce proved to be good phytoremediators.

Phytoextraction is the use of plants to accumulate and concentrate contaminants in their harvestable parts(chic.com). These innovative technology were intended to filter marine areas from heavy metals, such as lead(chic.com).

Lead is one of the heavy metals most present in contaminated waters(Timberlake 1996). These heavy metal have it origin from factories, chemical wastes, oil spills which are thrown in marine areas (Timberlake 1996). Lead is a difficult element for plants to hyperaccumulate(Timberlake 1996). A dose of lead that would have little effect on an adult can have a significant effect on a small, developing body(Timberlake 1996). Also, growing children will more rapidly absorb any lead they consume(Timberlake 1996).

In this research, the altered concentration of lead is our independent variable. The amount of lead absorbed is our dependent variable.

B. Statement of the problem or Hypothesis

This study aims to determine the potential of swamp cabbage as a phytoremediator of lead, its ability to suck or absorb lead at given concentrations.

The study answered the following objectives:

1.) To determine the significant difference in the rate of absorption of swamp cabbage in 2.5 ppm, 10.0 ppm, and 15.0 ppm lead concentration.

2.) To determine the significant difference in the amount of lead absorbed in the stem of swamp cabbage in 2.5 ppm, 10.0 ppm, and 15.0 ppm lead concentration.

3.) To determine the significant difference in the amount of lead absorbed in the roots of swamp cabbage in 2.5 ppm, 10.0 ppm, and 15.0 ppm lead concentration.

It is hypothesized that there is no significant difference in the:

1.) Rate of absorption of swamp cabbage in 2.5 ppm, 10.0 ppm, and 15.0 ppm lead concentration.

2.) Amount of lead absorbed in the stem of swamp cabbage in 2.5 ppm, 10.0 ppm, and 15.0 ppm lead concentration.

3.) Amount of lead absorbed in the roots of swamp cabbage in 2.5 ppm, 10.0 ppm and 15.0 ppm lead concentration.

**C.** Significance of the study

Oil spills, chlorinated solvents, sewage effluent, pesticides and mostly heavy metals thrown in large bodies of water have brought great recognition and alarm to environmental agencies. These occurrence are indeed precarious and certain effects are not favorable to living creatures.

Similar to that of Butalid et al., this study could help certain contaminated regions in removing contaminants in a natural way. Through the efforts of phytoremediation, marine areas that are polluted and contaminated water domains could be filtered and restore its ecological diversity again.

Even in some areas, coastal clean-up and waste clear out would amount to an immense budget. For example, cleaning up existing environmental contamination in the United States could cost as much as *$1 trillion* dollars. With this study, large factories and research institutes could use in cleaning their own vicinity in a more cost-efficient and safer way.

With phytoremediation, as well as rhizofiltration and phytoextraction, it would be more practical and useful compared to other engineered and innovative technologies. Phytoremediation offers lower cost, applicability to a broad range of metals, potential for recycling the metal-rich biomass.

Phytoremediation also minimize site disturbance compared with conventional cleanup technologies, post-cleanup costs can be substantially reduced.

**D.** Scope and Delimitations of the Study

Our study was conducted at the Philippine Science High School Western Visayas research laboratory. The contaminated water the researchers used by using lead acetate to ground water for the artificial contaminated water upon which the swamp cabbage was tested.

The ground water was taken from the vicinity of Philippine Science High School Western Visayas.

The test plant, which is the swamp cabbage, was taken from a farm pond from San Joaquin, Iloilo. The concentration of lead acetate was 2.5 ppm, 10.0 ppm, , 15.0 and .

Although phytoremediation is intended for a long period of time, the researchers technically planned the duration for five (5) days. The duration started from August 25 to September 3 2003.

E. Definition of Terms

For the purpose of clarity and single-mindedness, the following terms have been provided with conceptual and operational terminology.

Bioremediation- use of microorganisms in removing contaminants in contaminated areas.

(Contaminated) Water- an element vital to all human needs wherein it is polluted or impure due to the presence of dirty matters.

Lead- a heavy metal which melts easily and quickly. Lead has also has great resistance to different weather conditions. Unfortunately, lead compounds are toxic and can present a severe hazard to those who are over exposed to them.

Phytoextraction- the use of plants to remove contaminants from the environment and concentrate them in above-ground plant tissue.

Phytoremediation- uses photosynthetic plants to stabilize, collect, or chemically change contaminants to a nonhazardous form.

# Chapter II

# REVIEW OF RELATED LITERATURE

## PHYTOEXTRACTION

The use of plants to remove contaminants from the environment and concentrate them in above-ground plant tissue is known as phytoextraction(chic.org). Research and development efforts focus on two areas of study: (1) remediation of contaminants such as Pb, As, Cr, Hg, and radionuclides and (2) mining, or recovery, of inorganic compounds, mainly Ni and Cu, having intrinsic economic value. Phytoextraction can be used in both water and soil environments(chic.org).

Phytoextraction was primarily employed to recover heavy metals from soils, however, this technology is now applicable to other materials in different media(cluin.org). Green-house hydroponics systems using plants with high contaminant root uptake and poor translocation to the shoots are currently being researched for removal of heavy metals and radionuclides from water(cluin.org). These plants are also referred to as hyperaccumulators(cluin.org).

Plants with high growth rates (>3 tons dry matter/hectare-year) and the ability to tolerate high metal concentrations in harvestable parts of plants (>1,000 mg/kg) poplar trees can be used, however, there is concern about leaf litter and associated toxic residues(cluin.org).

Early research revealed that phytoextraction via constructed wetlands (used to purify water) was ineffective because it was difficult to remove inorganic elements that precipitated from the water into the sediments(edie.org). In addition, floating plant systems, with subsequent biomass harvesting, was determined to be inefficient and uneconomical(edie.org). Research on specific plant species determined that some plants concentrated toxic heavy metals of up to several percent of their dried shoot biomass(edie.org).

In phytoextraction, the water and the metals move through the soil towards the roots of the plants, where the extraction flow of the plants takes them into the plants' tissues(edie.org). The water and metals then move up into the stem and leaves, where the water evaporates(edie.org). The heavy metals remain in the plant(edie.org). As time goes by older plants are harvested by traditional agricultural methods.

## SWAMP CABBAGE

Swamp cabbage (*Ipomoea aquatica Forsk*) or water spinach as a herbaceous trailing vine that dwells in stream banks, freshwater ponds, and marshes(watergardenshop.com). This perennial aquatic plant is confined to the tropics and subtropics zones because it is susceptible to frost and does not grows well when temperature is below 23.9 C(watergardenshop.com).

Water spinach can reduce sexually by producing four to one seeds in fruiting capsules or vegetatively by stem fragmentation(watergardenshop.com). It is a member of the "morning-glory" family.

It's flower is funnel shaped, solitary or in few flowered clusters at leaf axis, two inches wide, pink to white in color, darker in the throat(rarely nearly white). Leaves are arrowhead shaped, alternate, one to six inches long, and one to three inches wide. It's vine are like trailing, with milky sap and roots at the nodes; usually to 9 ft. long but can be much longer.

Water spinach is an emersed plant(watergardenshop.com). It is not native to Florida. Like others in the morning-glory family, water spinach is a vine(watergardenshop.com).

## LEAD

Lead is a metal(becnet.org). Lead metals easily and quickly, and it can be molded or shaped onto thin sheets and can be drawn out into wire or threads(becnet.org). Lead also has great resistance to different weather conditions(becnet.org). Unfortunately lead and lead compounds are toxic and can present a severe hazard to those who are overexposed to them. Whether ingested or inhaled, lead is readily absorbed and distributed throughout the body(becnet.org).

Lead is widespread in the environment, and people absorb lead from a variety of source everyday(becnet.org). Although lead has been used in numerous consumer products, the most important sources of lead exposures to the general population are; soil and dust(which has been contaminated by air, which includes dust both inside and outside the home), food and drinking water(becnet.org).

On average, it is estimated that lead in drinking water contributes between 10-20% of total lead exposure in young children. Food is the greatest single source of lead for the average adult(becnet.org). In the past few years, federal controls on lead in gasoline and from industrial air emissions have significantly reduced total human exposure to lead(becnet.org).

Recently, more people become victims in lead poisoning because of its presence in drinking waters(becnet.org).

Chapter III

Research Design and Methodology

Most of our methodology were based on recent research conducted by Butalid et. al in the past two years.

**A.**

This study aimed to determine the potential of swamp cabbage as phytoremediator of lead.

It specifically compared the amount of lead in the stem and roots of swamp cabbage, and in water before and after phytoremediation in 2.5 ppm, 5.0 ppm, 7.5 ppm and one control test concentration of lead for ten days.

It also specifically compared the absorption rate of swamp cabbage in 2.5 ppm, 5.0 ppm, 7.5 ppm and one control test concentration of lead for ten days.

The Pretest-Posttest Control group in a completely Randomized Design was employed in achieving the aim of this study. The independent variable was the different lead concentrations in each set-up, 2.5 ppm, 5.0 ppm, 7.5 ppm and one control test concentration of lead.

The dependent variables were the absorption rate, the amount of lead in the stem and roots of the swamp cabbage and the amount of lead in water before and after phytoremediation of swamp cabbage. Swamp cabbage was grown in four set-ups containing four plants each. In set-up A, All plants from each set-up were harvested after ten days.

The lead concentration was determined by the PASCO lead Ion Probe in the Science Interactive Programs.

The results of the study were processed and analyzed using the mean and standard deviation as descriptive statistical tool and the t-test set at 0.05 alpha level of significance, as inferential statistical tool.

**B.** Gathering of materials

The plastic basins were borrowed from the PSHS-WV Girls Dormitory while the rest were purchased from the stores. The lead acetate was taken from the PSHS-WV Science Research Laboratory. The test plants were taken from Brgy. Bayunan, San Joaquin while the ground water was taken from the PSHS-WV. The twelve plastic basins were used as culture vessels for the plants in four different concentration set-ups. The lead acetate was used as the artificial source of contaminant lead in water. The ground water was used for maceration technique of lead content determination.

The reagent bottles, mortar and pestle , beaker, magnetic stirrer, stirring rod, lead ion probe and top loading balance were all borrowed from the PSHS-WV research laboratory. The reagent bottles were used as volume containers of water samples and macerated plant extract. The mortar and pestle was used in the maceration technique. The stirring rod was used during the regular mixing of lead-containing water in each set-up. The stirring rod was used during the lead content determination.

The PASCO Science Workshop Program (1997) was used in the lead content determination. The package contains a lead ion, a selective electrode, filling solution, a rubber cap, a rubber sleeve, an electrode connector, an interface amplifier. This program was run in a personal computer.

**C.** Preparation of lead concentration set-ups

Four lead concentration was used in this study. The initial lead content of the actual ground water was determined using the lead ion probe. After knowing the initial lead content, the researchers added the amount of lead acetate to reach the 2.5 ppm, 5.0 ppm, 7.5 ppm, and one control test concentration of lead.

**D.** Random Assignment of Test Plants

Different set-up were prepared and were labeled as Set-up A, B, C and D. Each set-up consisted of four plants that were randomly assigned.

**E.** Treatment Process

The test plants were exposed to the different lead concentrations for ten days. Then the test plants were harvested. The roots and the stems were removed and were macerated. The extracts from the macerated roots and stems were then tested for lead content with the use of the lead ion probe.

**F.** Statistical analysis of results

In determining the significance of the results, we used set the significance level at alpha 0.05 as the inferential statistical tool. The mean and standard deviation was used as descriptive statistical tool.

# CHAPTER 4

# RESULTS AND DISCUSSIONS

This study aimed to determine Swamp Cabbage as phytoremediator of lead.

It specifically compared the amount of lead accumulated in the stem, roots and water before and after phytoremediation of lead of Swamp Cabbage in 2.5 ppm, 10 ppm and 15 ppm lead concentration. It also determine the significant difference in the amount of lead accumulated in the stem, roots and water before and after phytoremediation of lead of Swamp Cabbage in 2.5 ppm, 10 ppm and 15 ppm lead concentration.

It was also hypothesized that there is no significant difference in the amount of lead accumulated in the stem, roots and water before and after phytoremediation of lead of Swamp Cabbage in 2.5 ppm, 10 ppm and 15 ppm lead concentration.

A. Amount of lead in the roots, stem and water of swamp cabbage before and after phytoremediation at altered concentrations.

Our results show the amount of lead absorbed by swamp cabbage in ten day duration. The data we obtained were expressed in Volts. One discrepancy in our results is that they cannot be expressed in Moles, then to milligrams because of the electric flow in the campus. The electric flow seemed to fluctuate and immediate measures cannot be employed at once because authorized personnel need more time. The results can only be processed on Saturdays because that was the day we started the first data gathering, and also because the electricity is less used.

However, our data, which also served as our results, was enough to elucidate any difference. There was a marked decrease in the amount of lead absorbed by swamp cabbage in ten days. The plant showed its potential to absorbed lead in 2.5 ppm, 10 ppm and 15 ppm lead concentration in ten days. Our table shows the results.

Table 1.0 Shows the amount of lead content in water, in Moles per Liter, of swamp cabbage after ten days.

| Lead concentration | Number of test plants | Average initial lead content | Average final lead content | Mean Difference |
|---|---|---|---|---|
| 2.5ppm + water | 5 | 0.518 | 0.516 | 0.002 |
| 10ppm + water | 5 | 2.072 | 2.063 | 0.009 |
| 15 ppm + water | 5 | 3.102 | 3.094 | 0.008 |

Table 1.1 Shows the amount of lead content in stems, in Moles per Liter, of swamp cabbage after ten days.

| Lead concentration | Number of test plants | Average initial lead content | Average final lead content | Mean Difference |
|---|---|---|---|---|
| 2.5ppm + stems | 5 | 0.518 | 0.515 | 0.003 |
| 10ppm + stems | 5 | 2.072 | 2.063 | 0.009 |
| 15 ppm + stems | 5 | 3.102 | 3.095 | 0.007 |

**Table 1.3 Shows the amount of lead content in roots, in Moles per Liter, of swamp cabbage after ten days.**

| Lead concentration | Number of test plants | Average initial lead content | Average final lead content | Mean Difference |
|---|---|---|---|---|
| 2.5ppm + roots | 5 | 0.518 | 0.515 | 0.003 |
| 10ppm + roots | 5 | 2.072 | 2.063 | 0.009 |
| 15 ppm + roots | 5 | 3.102 | 3.095 | 0.007 |

Our results show that there is indeed a marked difference in amount of lead absorbed in the test plant. It showed the amount of lead the plant absorbed in 15 ppm lead concentration and 10 ppm lead concentration (with a mean difference of 0.005 and 0.0036). While least is at 2.5 ppm lead concentration(with a mean difference of 0.049).

This shows that swamp cabbage was capable of phytoremediation as shown by the plants ability to remove lead in ten day duration. There was observed the greatest potency of swamp cabbage in 15 ppm and 10 ppm lead concentration. The pattern also follows where the least potency observed was in 2.5 ppm lead concentration.

significant difference in the amount of lead present in water, stem, roots of swamp cabbage in 2.5 ppm, 10.0 ppm and 15 ppm lead concentration after ten days.

The t-test showed that there was no a significant difference between the initial and final amounts of lead in water for all set-ups after ten days.

These indicate that swamp cabbage did not show any evident potential as natural filtrator of lead. There was observed no significant difference in the amount of lead in water, stem and roots of swamp cabbage at 2.5 ppm, 10 ppm and 15 ppm lead concentration.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This study aimed to determine the potential of swamp cabbage as phytoremediator of lead.

It specifically compared the amount of lead absorbed in the water, stem roots of swamp cabbage before and after phytoremediation of lead.

It also determined the significant difference in the amount of lead absorbed in the water, stem roots of swamp cabbage before and after phytoremediation of lead.

It was also hypothesized that there is no significant difference in the amount of lead accumulated in the stem, roots and water before and after phytoremediation of lead of Swamp Cabbage in 2.5 ppm, 10 ppm and 15 ppm lead concentration.

Findings:

1.1 The initial amount of lead content in the water in 2.5 ppm lead concentration was 0.310 volts. After phytoremediation of ten days the final amount was 0.261 volts, having a mean difference of 0.049 volts.

1.2 The initial amount of lead content in the water in 10 ppm lead concentration was 0.314 volts. After phytoremediation of ten days the final amount was 0.3104 volts, having a mean difference of 0.0036 volts.

1.3 The initial amount of lead content in the water in 15 ppm lead concentration was 0.321 volts. After phytoremediation of ten days the final amount was 0.316 volts, having a mean difference of 0.005 volts.

2.1 The initial amount of lead content in the stem in 2.5 ppm lead concentration was 0.320 volts. The final amount was 0.276, having a mean difference of 0.044 volts.

2.2 The initial amount of lead content in the stem in 10 ppm lead concentration was 0.319 volts. The final amount was 0.317, having a mean difference of 0.002 volts.

2.3 The initial amount of lead content in the stem in 15 ppm lead concentration was 0.313 volts. The final amount was 0.3106, having a mean difference of 0.0.0024 volts.

3.0 The initial amount of lead content in the roots in 2.5 ppm lead concentration was 0.311volts. The final amount was 0.282, having a mean difference of 0.028 volts.

3.0 the initial amount of lead content in the roots in 10 ppm lead concentration was 0.319 volts. The final amount was 0.312 volts, having a mean difference of 0.007 volts.

3.1 the initial amount of lead content in the roots in 15 ppm lead concentration was 0.313 volts. The finsl amount was 0.250 volts, having a mean difference of 0.062 volts.

## CONCLUSIONS

Swamp cabbage was proven to have no potential as phytoremediator of lead in ten days. The sum significant difference showed that it had no difference in absorbing lead in water, and the amount of lead in roots and stem before and after phytoremediation after the duration of ten days.

It was observed that though swamp cabbage may not have a significant amount of absorption, it was still capable of absorbing lead. The greatest potency was between 15 ppm and 10 ppm lead concentration, having a mean difference of 0.005 and 0.0036. The least observed potency was in 2.5 ppm lead concentration, having a mean concentration of 0.049.

# RECOMMENDATIONS

We strongly recommend the use of swamp cabbage as a natural filter and phytoremediator of contaminated waters were harmful contaminants are intolerable and the marine area is nonattainable. Swamp cabbage potentials could exhibit positive results in waste clean-ups.

Phytoremediation requires a longer time duration for it to exhibit the plant's potential in absorbing harmful contaminants, it is then recommended that using swamp cabbage should need a more longer span of time because this what phytoremediation actually requires. The duration would at least span of three years. This would lead to more superb results.

It is also recommended for further studies on using other more aquatic plant species that could exhibit potentials in absorbing toxic or other hazardous contaminants. Plants that could exhibit more significant results in absorbing harmful contaminants.

We also recommend that in determining lead concentration, further knowledge and observations should be considered, like the electric flow of the research area or the maintenance of the equipment. This would help in coming more accurate results and data. Furthermore, we recommend on using research areas with good flow of electric current and well-maintained equipments.

We would also recommend for further studies on the uses of swamp cabbage rather than natural filters. Studies on its natural importance and uses to mankind. We also strongly recommend that if swamp cabbage is used as phytoremediator, we suggest to use it only as a phytoremediator and not as a food or consumable plant once it has performed phytoremediation, this is to play safe.

# DOCUMENTATIONS

Figure 1.0 Maceration of roots and stem of swamp cabbage before and after phytoremediation

Figure 1.1 Actual culture of the test plant, swamp cabbage in the culture vessel for a duration of ten days.

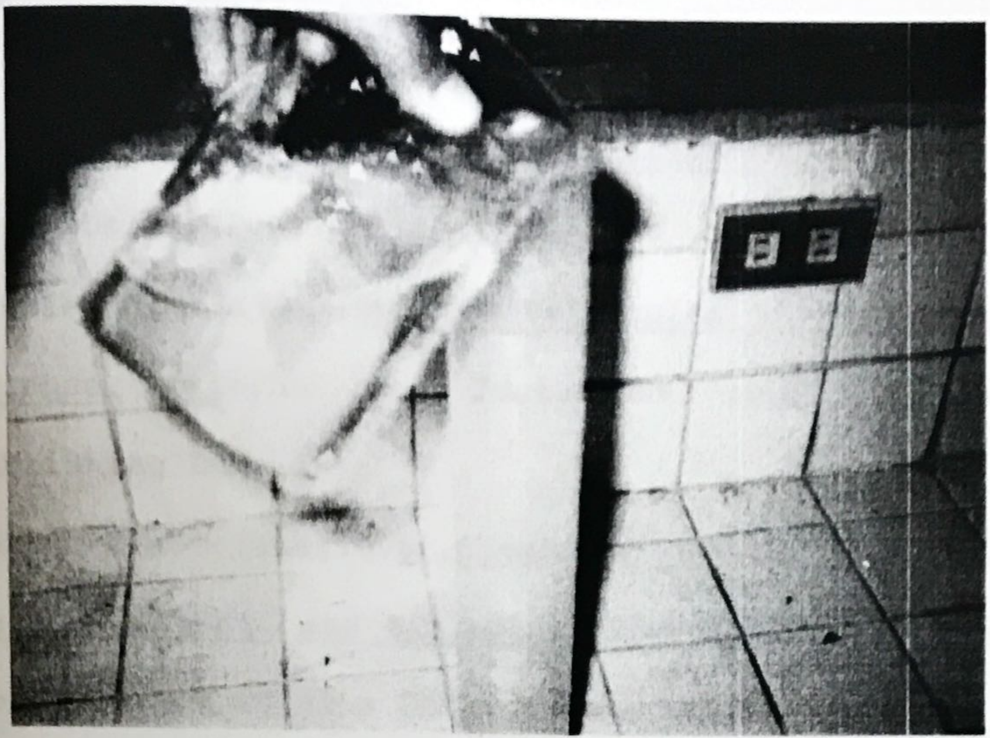

Figure 2.0 Preparation of the groundwater to be used in the culture vessel of the test plant.

Figure 2.1 Actual measurement of lead content in the plant's extract from its roots and stem.

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