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# WASTEWATER TREATMENT USING DUCKWEED AND COMPARATIVE STUDY OF COST EFFECTIVE DISINFECTION METHODS

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**Abstract –***Phytoremediation potential of duckweed Lemna minor was studied invitro for the period of seven days to investigate the removal of pollutants in surface water with special reference to heavy metals - lead and cadmium. After this cost effective disinfection also done there by water can be used for domestic purpose. 8 litre waste water was collected from astamudi lake. Waste water quality was assessed by analyzing Physico-chemical characters and obtained data was indicated as initial value. Lemna minor was cultured for the period of seven days and again water was analyzed for same physico- chemical parameters and obtained value was indicated as final value. The study revealed that pH, dissolved oxygen, had increased while values of COD, BOD, Lead, Cadmium, Chloride was decreased after seven days of culture. Through comparison of disinfection methods such as solar disinfection with lemon juice, solar disinfection with neem extract, solar disinfection with lemon juice and neem extract we concluded the best cost effective disinfection method is solar disinfection with lemon juice and neem extract.*

***Key Words*: Phytoremediation, Duckweed - Lemna minor, Lead, Cadmium, Astamudi lake, Cost effective, Disinfection**

## 1. INTRODUCTION

A heavy metal is any relatively dense metal or metalloids that are noted for its potential toxicity especially in environmental contexts. Heavy metal poisoning has particular application to cadmium, mercury, lead and arsenic all of which appear in the WHO's list of 10 chemicals of major public concern. Heavy metals can bind to and interfere with the functioning of vital cellular components. Common sources are mining and industrial wastes, vehicle emissions, lead-acid batteries , fertilizers, paints etc. A major concern for reuse of wastewater is the bioaccumulation of hazardous wastes especially heavy metals and pesticides in food chain.

The ultimate goal of waste water treatment and disinfection is to produce an effluent of such quality (for domestic use) that minimal additional controls are needed to manage any human health, agricultural or environmental risks. For wastewater reuse, the need for disinfection will depend on its intended uses. Discharge of effluent to surface waters will generally need disinfection. This reduces potentially harmful microorganisms in waste water to a level consistent with achieving the water quality standards. Among various methods of treating water at the point of use to reduce microbial pathogens, solar disinfection is a water treatment method where a water sample is exposed to solar radiation to inactive pathogenic organisms. It is seen as a low cost, sustainable and simple method of disinfection. The objective of this study includes comparison of solar disinfection with lemon juice, solar disinfection with neem extract, solar disinfection with lemon juice and neem extract. Lemon juice is commonly available cheap food product and neem extract is obtained from neem tree which is one of the natural herbs.

## 2. DUCKWEED

### 2.1 CHARACTERISTICS

Morphology: Duckweed (lemnacea) is a family of floating monocotyledons consisting of 4 genera (lemna, spirodela, wolffia and wolffiella) and 28 species. Their structure is very simple and distinct leaves and stems, distinguishable in other vascular plants, are replaced by a

fusion of both, called fronds. They are green and have a small size. They also have short but dense roots

Growth conditions: Duckweed grows on a wide range of quiescent or slow-current waters, and also relatively polluted waters, saline waters and eutrophic water bodies. Typical pH range is 4.5- 7.5, though duckweed growth is completely inhibited only at pH greater than 10.

Chemical composition: Apart from having high productivity, duckweed has high protein content and low fiber content. As a matter of fact, unlike the other higher plants, the entire plant body consists of metabolically active, nonstructural tissue.

### 2.2 MAIN AFFECTS OF DUCKWEED ON WASTEWATER TREATMENT

Duckweed play, compared to water hyacinth, a less direct role in the treatment process as they lack an extensive root system and therefore provide a smaller surface area for attached microbial growth. Therefore most of the biological activity in duckweed - covered pond is due to bacteria and other microorganisms suspended in the water column, as with any other lagoon system.

### 2.3 PRACTICAL INFORMATION ON THE USE OF DUCKWEED

Physical features of duckweed - covered ponds: Duckweed basins should be a constructed with a large length/ width ratio (higher than 10) to encourage plug - flow conditions in order to prevent short- circuiting and to simplify harvesting operations. Although dense, the surface mat of duckweed is susceptible to movement by the wind. Therefore, artificial windbreaks, emergent aquatic macrophytes are used to minimize disturbance. The harvesting operations can be carried out by means of specially designed aquatic harvesters or mechanical skimming devices. Manual harvesting is labour intensive and can be used only in smaller systems.

### 2.4 MANAGEMENT OF METAL HYPERACCUMULATOR DUCKWEED PLANTS

In spite of the cost effectiveness and environmentally friendly nature of phytoremediating (hyper-accumulating) plants, the fate of metal-saturated duckweed remains a burning issue. However, a few methods are used by they are anaerobic digestion for biogas production, hydrolysis, fermentation, briquetting, incineration, and carbonization. Anaerobic digestion of contaminated duckweeds fo biogas production is well- suited for the developing countries as they suffer from a power shortage. Metal speciation may be the only concern in the anaerobic digestion processes that needs to be investigated thoroughly. Increased biogas production can in turn reduce pressure on natural gas and oil consumption. Briquettes can be developed from the hyper
Accumulator duckweeds to be used in cooking food materials. Converting contaminated duckweeds into charcoal (carbonization) and incineration are also good options for getting rid of hyper accumulator plants and have limitation with respect to air pollution. Hydrolysis combined with fermentation can yield biofuels from contaminated duckweeds. All of these strategies greatly depend on the metal concentrations present in duckweed plants, and their application requires skilled operational protocols.

## 3. SURVEY OF STUDY AREA

### 3.1 STUDY AREA

Waste water sample was collected from ashramammudi region of Astamudi Lake. Astamudi lake located in the Kollam district, is the second largest estuarine system in Kerala with a water spread area of about 32 $km^2$ the lake is located between latitude 80 53'90 2' N and longitude 760 31'-760 41' E. The main basin is approximately 13 km long and the width varies from a few 100 m to about 3 km.

### 3.2 POLLUTION STATUS

The lake is under pollution stress on many pockets that are localized to urbanization of Kollam town. Several major and minor drainage channels loaded with waste products from municipal and industrial sources join the lake at the southern end. Ashramam mudi region of Astamudi Lake. It is the most polluted area of Astamudi Lake. According to the oral survey conducted among the workers in the house boat and tourism department main sources of solid waste in the astamudi lake are the Prawn processing factory , Beverage godown , Hockey stadium, Transport bus stand , District hospitals, Municipality-houses, shops and construction activities etc.

## 4. MATERIALS AND METHODS

### 4.1 EXPERIMENTAL SETUP

Waste water of 8 liter was collected with the help of sampling bottles at a depth of 30 cm from the surface of lake. Its physio-chemical parameters were studies

through analysis. Collected duckweed ( lemna minor) from nearby aquarium and washed it with distilled water. Cultured duckweed in a basin containing water sample for the period of seven days, amount of duckweed is based on the water surface area.

### 4.2 ANALYSIS OF WATER QUALITY BEFORE AND AFTER PHYTOREMEDIATION

Surface waste water quality was determined by analyzing Physico- chemical parameters like pH, Chloride, Dissolved oxygen, Chemical oxygen demand, and Biological oxygen demand, Atomic absorption spectroscopy in before and after phytoremediation with the duckweed for seven days. The values before phytoremediation were noted as initial value while the values recorded after the was indicated as final value.

Phytoremediation potential of Duckweed ( lemna minor) in the removal of pollutants from waste water was studied by analyzing the waste water before and after the phytoremediation by duckweed.

Table -1: Values before and after the phytoremediation

| TESTS | INITIAL | FINAL |
|---|---|---|
| pH | 6.85 | 7.1 |
| Chloride | 452 mg/l | 195 mg/l |
| Lead | 0.492 mg/l | 0.010 mg/l |
| Cadmium | 0.06 mg/l | 0.003 mg/l |
| DO | 1.9 mg/l | 8 mg/l |
| BOD | 7.3 mg/l | 4.5 mg/l |
| COD | 19.5mg/l | 8.2 mg/l |

## 5. DISINFECTION

There are number of chemicals and processes that will disinfect water, but none are universally applicable. Most of the septic tank of municipalities discharges its waste to the Astamudi Lake. So disinfection is mandatory for treated water which is used for domestic purpose.

### 5.1 MATERIALS

### 5.11 NEEM

Neem tree belongs to the family Meliaceae which is found in abundance in tropical and semi tropical region like India, Bangladesh, Pakistan and Nepal. It is a fast growing tree with 20-23 cm tall and trunk is straight and has a diameter around 4-5 ft. The leaves are compound, imparipinnate, with which turn golden yellow on ripening in the months of june- August.

Azadirachta indica shows therapeutics role in health management due to rich source of various types of ingredients. The most important actuve constituent is azardirachin and the others are nimbolinin, gedunin, salannin and quercetin.

Active constitutes play role in the diseases cure via activation of antioxidative enzyme, rupture the cell wall of bacteria and play role as chemopreventive through the regulation of cellular pathways. Neem and its ingredients play role in the inhibition of growth of numerous microbes such as viruses , bacteria and pathogenic fungi.

NEEM EXTRACT: Clean leaves were made into paste with distilled water using mortar and pestle. The paste

was then diluted and filtered through muslin cloth and extract was made upto 20 ml.

### 5.12 LEMON

Pure lemon juice may kill some bacteria, because bacteria may not able to grow under acidic conditions and thus could be rendered inactive or dormant until cnditions improve.

LEMON JUICE : Squeeze 6 lemons and 20 ml of lemon juice was collected.

### 5.2 METHODOLOGY

Bacteria count of the treated water was tested using plate count method.

SOLAR DISINFECTION WITH LEMON JUICE- 700 ml of sample was taken and diluted it with 10 ml of lemon juice , placed it in the sunlight about 3 hrs.

SOLAR DISINFECTION WITH NEEM EXTRACT- 700 ml of sample was taken and diluted it with 10 ml of neem extract, placed it in the sunlight about 3 hrs.

SOLAR DISINFECTION WITH LEMON JUICE AND NEEM EXTRACT- 700 ml of sample was taken and diluted it with 10 ml of lemon juice and 10 ml of neem extract, placed it in the sunlight about 3 hrs.

Table - 2 : Bacterial count before and after disinfection

| DISINFECTION METHODS | Bacteria count before disinfection | Bacteria count after disinfection |
|---|---|---|
| Solar disinfection with lemon juice | 120 cfu/500 ml | 110 cfu/500 ml |
| Solar disinfection with neem extract | 120 cfu / 500 ml | 86 cfu /500 ml |
| Solar disinfection with lemon juice and neem extract | 120 cfu / 500 ml | 4 cfu / 500 ml |

## 6. RESULT AND DISCUSSION

Lemna minor has a great potential in phytoremediation for removal of pollutants with special reference to heavy metals like lead and cadmium from surface waste water.

Through comparative study of disinfection, solar disinfection with lemon juice and neem extract is the effective disinfection method. Water sample can be safely used for domestic purpose because it obeys drinking water standards.

Table - 3 : Permissible limits of mineral, and heavy metals and bacteria in drinking water

| CONTENTS | CONCENTRATION |
|---|---|
| Chloride | 250 mg/ l |
| DO | 4-8 mg/l |
| BOD | 1-2 ppm( very good )<br>3-5 ppm (medium clean)<br>6-9 ppm ( organic matter present)<br>10+ ppm (very polluted) |
| COD | 10 ppm |
| Lead | 0.015 mg ( 0.010 mg or less safe) |
| Cadmium | 0.005 mg |
| pH | 6.5 - 7.5 |
| Total bacteria count limit in drinking water | If 100 ml of water was analysed, the detection limit is less than 1 colony forming units per 100 ml |

## 7. CONCLUSION

Hazardous heavy metal pollution of waste water is one of the most important environmental problems throughout the world. To meet the increased more stringentent environmental regulations, a wide range of treatment technologies such as chemical precipitation, coagulation- flocculation, floatation, ion-exchange and membrane filtration have been developed for heavy metal removal from waste water. They require high cost and non ecofriendly. As well as conventional method of disinfecting water are economically non feasible & also people reluctant to use chemicals as disinfectants. This treatment method and disinfection method is cost effective and ecofriendly for sustainable development and water can be used for domestic purpose like cleaning, flushing etc.

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