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Feasibility Study of Powdered Curry Leaf and Amla Fruit as Potential Filter Media for Treating Contaminated Lake Water

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Abstract: Municipal supply of contaminated water bodies are endangering the health of people mainly due to the spreading of vector-borne diseases. Filtration is generally accepted as the most feasible treatment for water that is contaminated by physical, chemical or biological impurities. The economic viability of filtration units in water treatment plants depend a large extent to the selection of suitable filter media that can guarantee reasonable overall removal efficiency for the pollutants. In this study, an attempt has been made to purify a large contaminated surface water body (known as Pedda Cheruvu) in Vizianagaram by filtration technique using low cost materials. Cheap and economical materials like curry leaves and amla were used as filter media in order to evaluate their potential for removing the settleable solids as well as dissolved solids from water. The physical parameters such as turbidity, total dissolved solids (TDS), total hardness, calcium hardness and kinetics of filtration were monitored during the laboratory experiments. Results suggest that acid-treated amla powder has a better overall removal efficiency for removing turbidity (90.86%), total hardness (46.67%) and calcium hardness (41.33%) whereas oven-dried curry leaves resulted in higher removal efficiency for TDS (22.38%).

Keywords: *Filtration, curry leaf, amla fruit, lake water, turbidity, Hardness*

1. Introduction

Drinking water supply and sanitation in India continue to be inadequate as the country's water demand is expected to exceed all possible sources of supplies, and the country is set to become water scarce by 2025. Due to rapid increase in the number of industries, population, urbanization etc., there is a lot of degradation and deterioration of the surface and subsurface water sources. While selecting a large surface water body as the source of drinking water supply for a community, it is very difficult for the municipalities to maintain the required water quality standards through their existing water supply system. The increasing demand for portable water purifiers across the country shows the people's concern about their health and safety. Therefore, it is mandate to have adequate treatment facility for the water, either at the source, or at the individual delivery point.

Based upon the natural and anthropogenic sources, water pollutants have been classified into eight types viz. disease-causing agents, sediments, inorganic plants, algal nutrients, organic compounds, inorganic chemicals, radioactive substances, and thermal pollutants [1]. Industrial and man-made activities contribute a large volume of contaminants which aggravate the pollution in the water systems in the current scenario. When the water is polluted beyond the limits, the natural mechanism of the rivers and streams cannot recuperate themselves against the pollutants. Inevitably we are moving to a critical situation where primary treatment is mandate for water from any natural source before using it for domestic activities.

In order to provide clean and safe drinking to people, the contaminants have to be completely removed from water either by physical or chemical or biological methods or a combination of all. These methods depend on the physicochemical properties, concentration of pollutants, quality of water sample, economy of the method adopted and many other factors. The easiest methods of natural purification are adsorption and filtration of the contaminants onto the surface of natural adsorbents like clay, rocks and biomass [2, 3].

Design and development of various types of filter media has been carried out since many years. Ref. [2] developed a low cost ceramic silver-impregnated pot filter (CSF) to treat water at the household level. Ref. [3] fabricated a low cost, micro-porous ceramic water filter using the slip casting process. Ref. [4] developed a low cost treatment technique using locally available materials to make water suitable for drinking purpose. Ref. [5] developed a simple and cheap water filtration technique using a graded multi-media filter bed for

providing water supply to the public and industries. Ref. [6] developed a low cost purification technique using the basic concepts of slow sand filter and locally available materials like charcoal, sand, manganese modified sand, clay, rice husk, banana residue ash, anthracite for purifying surface water source. Ref. [7] used herbal technique in an approach to make water suitable for drinking purpose. Locally available material like tulasi leaves powder, neem leaves powder, rice husk and sugarcane bagasse was used.

The aim of the present study is to analyze the efficiency of using low cost agricultural products like curry leaves and amla fruits as a suitable replacement for the fine layers in filtration media. In this study, an attempt has been made to purify the polluted water from Pedda Cheruvu Lake and the removal efficiency has been compared in terms of major water quality parameters such as turbidity, total dissolved solids, total hardness, calcium hardness.

2. Methodology

2.1 Study Location

Pedda Cheruvu is a large lake located in Vizianagaram district of Andhra Pradesh, India (18°4'9"N 83°28'17"E). It is the major source of irrigation in Denkada village covering an area of 162 acres (about 25-30 percent of land). The lake is normally recharged by rainwater as well as canal diversion from Champavati River. The three-century-old tank is now filled with sewage overflowing from a nearby sewage treatment plant, endangering the locality with vector-borne diseases.

As a preliminary study for the water quality assessment and treatment, water samples were collected from four different locations in Pedda Cheruvu as shown in Fig.1. The samples were collected 15 cm (approximately) below the water surface level and stored in polyethylene bottles. The flask was filled completely and stopped with a cork in such a way that there is no air above the sample.

Figure 1 *(a) Satellite map and (b) land image of Pedda Cheruvu lake in Vizianagaram which is contaminated by many sewage drains*

2.2 Preparation of Filter Media

Curry leaves (*Murraya koenigii*) and amla fruit (*Phyllanthus emblica*) were bought from a market in Visakhapatnam. Initially, the curry leaves were oven dried for one day and then it was pulverised using a mixer. This pulverised curry leaves powder was cleaned thoroughly with water for the removing the colour. Similarly, amla fruit was chopped into small pieces and sun dried for four days. Then it was kept in oven for three days and it is pulverised using mixer. This pulverised amla fruit powder was cleaned thoroughly with water to remove colour and it was treated with 10ml acetone which was diluted with 100ml of distilled water and after some time it is treated with 10ml acetic acid which is also diluted to 100ml of distilled water. Then, it was dried in sun for 24hrs. Again this, sample was treated with 10ml nitric acid which was diluted with 100ml of distilled water. This treatment with nitric acid was repeated in the same manner for a week.

Sand used in the filter is of two sizes 425µ (retained) and 600µ (retained). It has a uniformity coefficient (Cu) of 1.4 and specific gravity (G) of 2.58. Sand was thoroughly cleaned with water because the silt content in the sand can impart colour to the filtrate.

A simple cylindrical filtration model is designed as shown in Fig. 2 with a length of 192mm, and outer and inner diameters as 89mm and 87mm respectively. The base portion is covered with glass beads of thickness of 20mm. From the base, the outlet is extended to collect water with a pipe as shown in the Fig. 2. A pipe of 2mm diameter was connected with the inlet pipe. In the proposed model, the water of known concentrations was passed through the inlet pipe. Initially a layer of fine sand of specified thickness was placed. Then the filter media of specified thickness was placed, and another layer of coarse sand of specified thickness was laid over it. After filtration, the filtered water was collected through the outlet pipe in a beaker and the final concentrations were measured. The rate of filtration was also noted and for each adsorption media three or

more samples were tested and average concentrations was considered for analysing filter effectiveness.

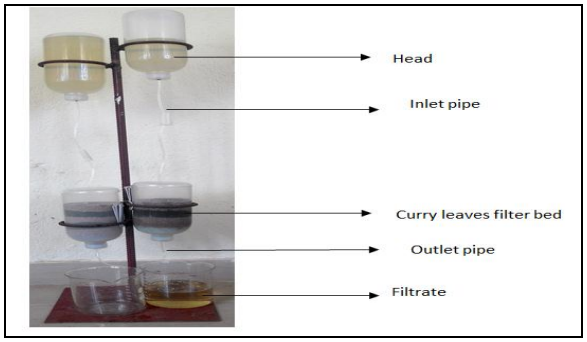

Figure 2 *Filter model with oven dried curry leaves powder as filter bed*

3. Results and Discussion

3.1 Rate of Filtration

An attempt was made to purify the contaminated water using filtration using low cost adsorbents. Low cost materials like curry leaves and amla powder was used as a part of the filtration media. The rate of filtration has been tabulated below.

Table 1 *Rate of filtration for different adsorbents*

Water sample	Oven dried curry leaves ml/sec	Acid treated amla ml/sec
1	0.18	1.9
2	0.79	1.1
3	0.59	1.05
4	0.66	0.92

It is observed from Table 1 that the rate of filtration was initially low when oven dried curry leaves were used but the rate increased with time and passing of consecutive water samples into the filter bed. This is because the filter bed was dry to begin with and with increase in saturation, the rate of filtration has increased. On the other hand, for acid treated amla, the rate of filtration was initially very high but the rate has reduced with consecutive water samples.

3.2 Removal Efficiency with Curry Leaves

The initial and final concentration of water sample after filtration using oven dried curry leaves powder has been tabulated below.

Table 2 *Initial and final concentration of water sample*

S. No	Parameters	Initial concentration	Final concentration	% Reduction
1	Turbidity	121 NTU	45 NTU	62.80
2	Total dissolved solids	670 ppm	520 ppm	22.38
3	Total hardness	415 ppm	410 ppm	1.20
4	Calcium hardness	68 ppm	58 ppm	14.71

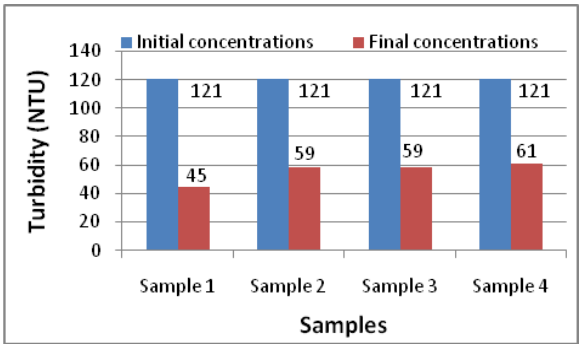

Figure 3 *Comparisons of initial and final concentration of turbidity using oven dried curry leaves as an adsorbent material*

Fig. 3 shows initial and final concentration of turbidity before and after filtration using oven dried curry leaves as an filter media. Initial concentration of turbidity was 121 NTU and after filtration, for sample 1 it reduced to 45 NTU and for sample 2 it increased to 59 NTU, for samples 3 and 4 it increased to 59 NTU and 61 NTU. For sample 2, the turbidity increased because water sample 2 was passed through the filter bed a day after passing sample 1. Due to the time gap the filter bed was spoiled. Oven dried curry leaves was able to remove turbidity to an extent of 62.8%.

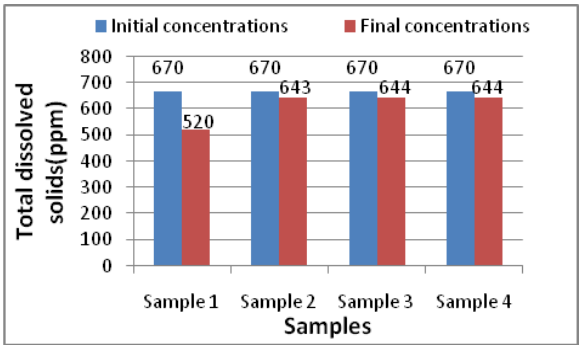

Figure 4 *Comparison of initial and final concentration of total dissolved solids using oven dried curry leaves as an adsorbent material.*

Fig. 4 shows initial and final concentration of total dissolved solids before and after filtration using oven dried curry leaves as an effective filter material. Initial concentration of total dissolved solids was 670 ppm and after filtration, for sample 1 it reduced to 520ppm, for sample 2 it increased to 643ppm, for sample 3 and sample 4, it increased to 644 ppm respectively. Oven dried curry leaves was able to remove total dissolved solids to an extent of 22.38%. For sample 2 the total dissolved solids increased because water sample 2 was passed a day after passing sample 1 which resulted in low efficiency of the filter bed.

Fig. 5 shows initial and final concentration of total hardness before and after filtration using oven dried curry leaves as a potential filter media. Initial concentration of total hardness was 415 ppm, for sample 1 after filtration it increased to 450 ppm, for

sample 2 it decreased to 410 ppm and for sample 3 and 4 it increased to 430 ppm and decreased to 420 ppm respectively. The sand and adsorbent material in the filter media and ionized matter present in the water carry electrical charges of opposite nature, therefore they attract opposite charges. As a result while filtration the chemical constituents of water gets modified. Due to long usage of the filter media, the electric charge capacity gets reduced which can be renewed by washing the filter bed.

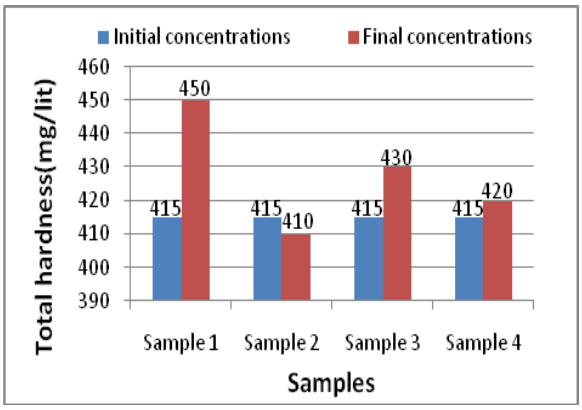

Figure 5 *Comparison of initial and final concentration of total hardness using oven dried curry leaves as an adsorbent material.*

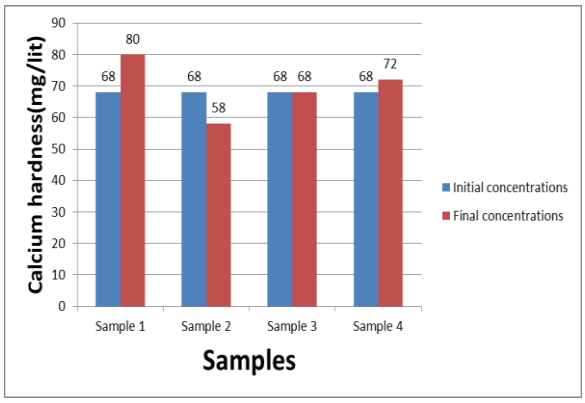

Figure 6 *Comparison of initial and final concentration of calcium hardness using oven dried curry leaves as an adsorbent material*

Fig. 6 shows initial and final concentration of calcium hardness before and after filtration using oven dried and powdered curry leaves. Initial concentration of calcium hardness was 68 ppm and after filtration for sample 1 after filtration it to increase to 80 ppm, for sample 2 concentration decreased to 58 ppm, for sample 3 there is no change in concentration and for sample 4 there is slight increase in the concentration up to 72 ppm. Oven dried curry leaves was able to remove calcium hardness to an extent of 14.7%.

3.3 Removal Efficiency with Amla powder

The initial and final concentration of water sample after filtration through acid treated amla powder has been tabulated below.

Table 3: *Initial and final concentration of water sample before and after filtration using acid treated amla as an adsorbent material*

Parameters	Concentration		% Reduction
	Initial	Final	
Turbidity	536 NTU	49 NTU	90.86
TDS	597 ppm	496 ppm	16.92
Total hardness	375 ppm	200 ppm	46.67
Calcium hardness	150 ppm	88 ppm	41.33

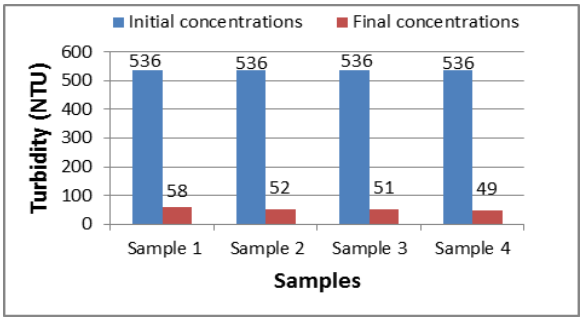

Figure 7 *Comparison of initial and final concentration of turbidity using acid treated amla powder as an adsorbent material*

Fig. 7 shows initial and final concentration of turbidity before and after filtration using acid treated amla powder. Initial concentration of turbidity was 536 NTU after filtration sample 1 it decreased to 58 NTU, for sample 2 it decreased to 52 NTU, for samples 3 and 4 it decreased to 51 NTU and 49 NTU. Acid amla was able to remove turbidity to an extent of 62.8%. Sand consists of small pores if water is allowed through sand volume containing suspended particle cannot pass through sand bed and removed. While passing water sample through the filter media suspended matter in the water gets clogged in pores of sand bed and form a settled mat due to which turbidity in the water decreases.

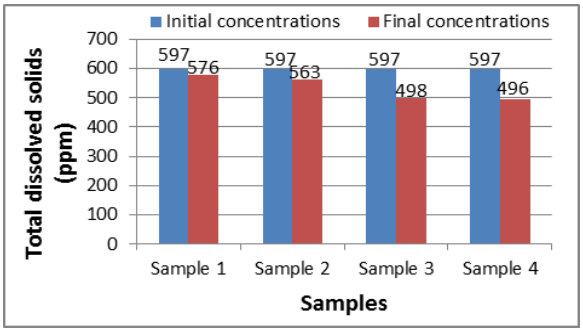

Figure 8 *Comparison of initial and final concentration of total dissolved solids using acid treated amla as an adsorbent material*

Fig. 8 shows initial and final concentration of before and after filtration using acid treated amla powder as a potential filter media. Initial concentration of total dissolved solids was 597 ppm after filtration, for sample 1 it reduced to 579 ppm, for sample 2 it

reduced 563 ppm and for samples 3 and 4 total dissolved solids it reduced to 498 ppm and 496 ppm. Acid treated amla was able to remove total dissolved solids to an extent of 16.9%. The voids present in the sand bed acted like small settling basins. Very small particles of suspended matter, colloidal particles and some bacteria settled in these small settling basins due to adhesion between the particles of sand which was the reason for reduction in the concentration of total dissolved solids.

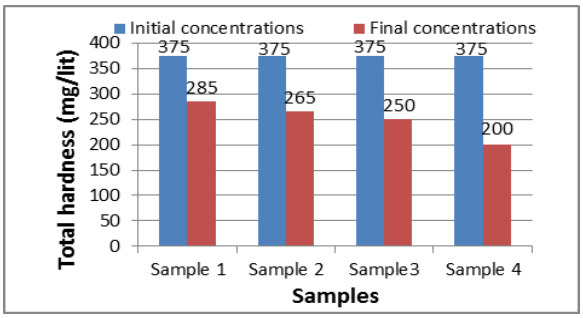

Figure 9 *Comparison of initial and final concentration of total hardness using acid treated amla as an adsorbent material*

Fig. 9 shows initial and final concentration of total hardness before and after filtration using acid treated amla as an filter material. Initial concentration of total hardness was 375 ppm after filtration for sample 1 it reduced to 285 ppm, for sample 2 it reduced to 265 ppm, for samples 3 and 4 it reduced to 250 ppm and 200 ppm respectively. Acid treated amla was able to remove total hardness to an extent of 46.6%. The sand and adsorbent material in the filter media and ionized matter present in the water carry electrical charges of opposite nature which makes them get attracted to each other. While filtration, the chemical constituents of water may get changed due to which the total hardness has decreased gradually with the passing of water samples into the filtered media.

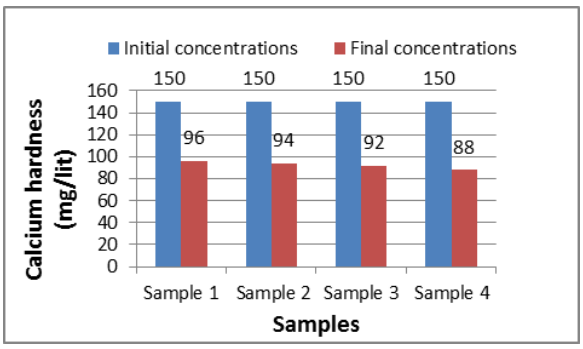

Figure 10 *Comparison of initial concentrations and final concentrations of calcium hardness using acid treated amla powder as an adsorbent material*

Fig. 10 shows initial concentration and final concentration of calcium hardness before and after filtration using acid treated amla powder. Initial concentration of calcium hardness was 150 ppm; after filtration, sample 1 calcium hardness was reduced to 96 ppm, for sample 2 it reduced to 94ppm, for samples 3 and 4 it reduced to 92 ppm and 88 ppm respectively. Acid treated amla was able to remove calcium hardness to an extent of 41.33%.

4. Conclusions and Recommendations

An attempt was made to filter the water collected from Pedda Chevuru Lake using filtration. Oven dried curry leaves and acid treated amla powder were the low cost adsorbent materials used to form a part of the filter bed. The conclusion from the present study is as follows:

1. Turbidity, total dissolved solids, total hardness and calcium hardness were reduced by 62.8%, 22.38%, 1.2% and 14.71% when oven-dried curry leaves were used in the filter bed.
2. Turbidity, total dissolved solids, total hardness and talcium hardness were reduced by 90.86%, 16.92%, 46.67% and 41.33% when acid treated amla powder was used as filter media.
3. As the sediment load is very high in the lake water as indicated by turbidity and total solids, it is important to have a pre-treatment unit like plain settling for effectiveness of the filter unit.
4. It is to be understood that due to the high concentration of solids in the lake water, natural biodegradation of undigested sewage will remain incomplete and can become high septic.
5. The present study envisage the actual threat to the consumers in terms of coli form bacteria present in the lake water which is to be effectively removed by employing some low-cost technique such as dual-media filtration.

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