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Phytoremediation potential of Azolla

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Abstract - *Pollution of water is a major threat we face today. Increased population and industrialization are the common factors that fasten the water pollution rate. Here pollution by dairy wastewater, domestic wastewater and municipal wastewater are taken in to account and solution to it by a modern cheapest method known as phytoremediation is studied here. Every day, dairy industries produces large amount of wastewater during processing. Increase in population leads to high domestic water consumption and domestic wastewater production. Domestic wastewater also plays an important role in polluting water resources. Municipal wastewater also contributes much to water pollution. Here experiments are conducted to assess effectiveness of phytoremediation technique using azolla pinnata plant over dairy wastewater, municipal wastewater and domestic wastewater. Parameters like pH, Turbidity, COD, Nitrogen and Phosphorus were analyzed before and after treatment. Also comparative study is conducted in the case of three wastewater.*

Key Words*: *Phytoremediation, Dairy wastewater, Domestic wastewater, Municipal wastewater

1. INTRODUCTION

Earth is often referred to as the water planet. Earth is unique amongst planets of our solar system largely because of its abundant water-in oceans, in the atmosphere, in glaciers and as fresh water on land. Without water, life could not exist. The world's thirst for water is likely to become one of the most pressing resource issues of the 21st century. Increasing urbanization, industrialization and over population is one of the leading causes of environmental degradation and pollution. Water resources around the world have been overused, polluted, fought over and squandered with little regard for human health and ecological consequences. Global water consumption tremendously increased with high population growth rate. The dawning of the 21st century brings with it a global water crisis. According to UNESCO currently more than one third of the world's population experiences serious water problems and polluted water sickens more than 1 billion people each year.

Researchers are focused on developing sustainable wastewater treatment technologies. Recently, new sustainable treatment options have emerged targeting the recovery and beneficial use of the nutrients and carbon present in wastewater as an alternative to conventional high-energy aerated biological treatment methods.

Phytoremediation is such a method where the ability of plants to survive in polluted water and to facilitate pollutants removal from the environment is exploited. The main advantage of phytoremediation is that it is very economic and eco friendly method of treatment when compared to other physical and chemical methods of wastewater treatment. The ability of aquatic plants to grow in nutrient rich water and to efficiently remove nutrients and metals from wastewater make them an attractive option for integrating into wastewater treatment plants. Also, they have very high growth rates and hence produces potentially valuable biomass which can be used for the production of a variety of liquid and solid biofuels. The focus on the use of biomass as an alternative feedstock to fossil fuels is intensifying due to its role in reducing CO_2 emission.

1.1 Objectives

- To make use of phytoremediation technique to treat dairy wastewater, municipal wastewater and domestic wastewater.
- To check the potential of Azolla pinnata plant for phytoremediation.
- To check the removal efficiency of pH, Turbidity, COD, Nitrogen and Phosphorus of the sample before and after phytoremediation.

2. METHODOLOGY

2.1 Experimental Layout

The experiment was conducted for wastewater obtained from dairy, municipal wastewater and domestic wastewater. Azolla pinnata was the plant used for experimental study. They were collected from CWRDM (Centre for Water Resources Development and Management), Kozhikode. 20 g of azolla was collected from CWRDM in plastic bags.

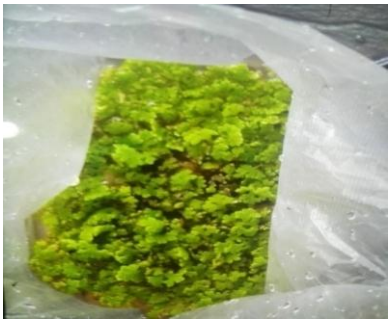

Fig -1: Azolla pinnata

Azolla is cultured in a trough by mixing cow dung lightly with water and also add 25 g of phosphorus in to it. The arrangement is kept under light shade for 15 days and growth of azolla has increased.

Fig -2: Initial stage of culturing

Fig -3: After 15 days of culturing

Before phytoremediation azolla is washed with distilled water and wet weight is taken. 20 g of azolla is used in each wastewater troughs.The wastewaters were collected in sterilized containers. The municipal wastewater sample was collected from the inlet of Medical college sewage treatment plant located at Medical college, Kozhikode. Dairy wastewater samples were collected from Milma dairy plant, Kunnamangalam, Kozhikode. It was collected from inlet of wastewater treatment plant. Domestic wastewater was collected from PVS flat, Palazhi, Kozhikode. The wastewater collected from the screen. Various wastewaters such as wash water, grey water, wastewater from septic tank etc reaches the inlet of treatment plant. As COD of the dairy wastewater exceeds 1000 mg/l, 50% dilution should be provided.

3. RESULTS AND DISCUSSIONS

3.1 Dairy wastewater

The colour of dairy wastewater is initially thick white and highly turbid nature and it gradually changed to clear colourless effluent after phytoremediation. The influent dairy wastewater had a pungent smell. The smell gets highly reduced after three days of phytoremediation. Almost all smell was eliminated after 7 days. The phytoremediation stages of Azolla pinnata over dairy wastewater are given in the figures. As in the figure there is a gradual multiplication and growth during phytoremediation.

Fig -4: Initial stage of filling azolla in the trough containing dairy wastewater

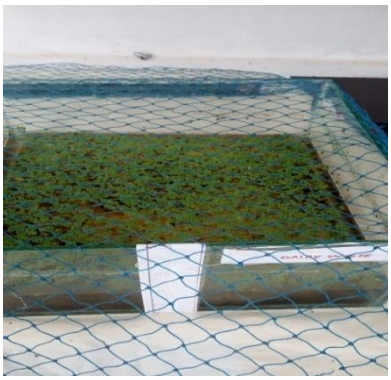

Fig -5: Azolla after 15 days in dairy wastewater

Fig -6: Azolla after 30 days in dairy wastewater

The dairy wastewater and Azolla was covered with a net to prevent excessive heating. The effluent was collected using a siphon at 15th and 30th day to determine the parameters such as pH, turbidity, COD, nitrogen and phosphorus using standard laboratory procedures. Table1 shows the dairy wastewater characteristics by phytoremediation effect.

Table -1: Dairy wastewater characteristics by phytoremediation effect

Parameter	Initial	15 days	30 days
pH	6.7	6.6	6.4
Turbidity (NTU)	500	250	10
COD (mg/l)	990	120	26
Nitrogen (mg/l)	30	12.3	7.1
Phosphorus (mg/l)	3.9	2.1	0.5

3.2 Domestic wastewater

The domestic wastewater is initially brownish and turbid nature gradually changed to clear colourless effluent after phytoremediation. The smell of domestic wastewater was reduced after 3 days of phytoremediation. Almost all smell was eliminated after 7 days. The phytoremediation stages of Azolla pinnata over domestic wastewater are given in the figure. As in the figure there is a gradual multiplication and growth during phytoremediation.

Fig -7: Initial stage of filling azolla in the trough containing domestic wastewater

Fig -8: Azolla after 15 days in domestic wastewater

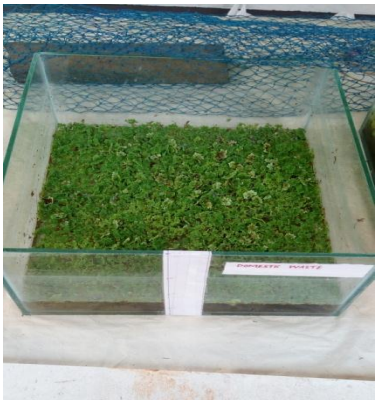

Fig -9: Azolla after 30 days in domestic wastewater

Table -2: Domestic wastewater characteristics by phytoremediation effect

Parameter	Initial	15 days	30 days
pH	6.3	6.1	6.0
Turbidity (NTU)	80	40	6
COD (mg/l)	280	125	20
Nitrogen (mg/l)	70	45	14
Phosphorus(mg/l)	45	4	2

3.3 Municipal wastewater

The municipal wastewater is initially brownish and turbid nature gradually changed to clear colourless effluent after phytoremediation. The smell of municipal wastewater was reduced after 3 days of phytoremediation. Almost all smell was eliminated after 7 days. The phytoremediation stages of Azolla pinnata over municipal wastewater are given in the figure. As in the figure there is a gradual multiplication and growth during phytoremediation.

Fig -10: Initial stage of filling azolla in the trough containing municipal wastewater.

Fig -11: Azolla after 15 days in municipal wastewater

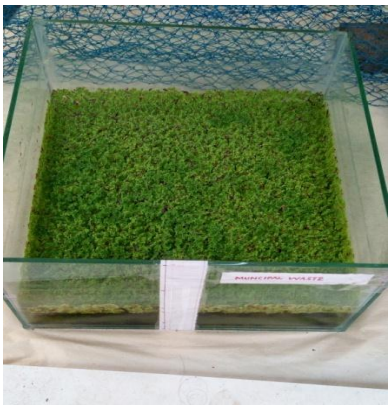

Fig -12: Azolla after 30 days

Table -3: Municipal wastewater characteristics by phytoremediation effect

Parameter	Initial	15 days	30 days
pH	6.6	6.54	6.3
Turbidity (NTU)	90	45	9
COD (mg/l)	380	70	50
Nitrogen (mg/l)	12	6	0.9
Phosphorus (mg/l)	20	7	1

3.4 Comparative study

Comparative study of phytoremediation effect in dairy wastewater, domestic wastewater and municipal wastewater using Azolla pinnata is as follows:-

3.4.1 pH

The pH of dairy wastewater is initially 6.7. The resultant effluent is slightly acidic after phytoremediation. In the case of domestic wastewater the pH is initially 6.3 The resultant pH of effluent slightly changes to acidic after phytoremediation. In the case of municipal wastewater the pH is initially 6.6. Here also the resultant pH changes to acidic after phytoremediation.

3.4.2 Turbidity

The turbidity of dairy wastewater, domestic wastewater and municipal wastewater are gradually decreasing. The % removal efficiency of turbidity in dairy wastewater is greater than the domestic wastewater and municipal wastewater. The % removal efficiency in dairy wastewater is 98% whereas in domestic wastewater and municipal wastewater are 92.5% and 90% respectively.

3.4.3 COD

The initial concentration of COD was 990 mg/l in dairy wastewater. It is reduced to 26 mg/l in the effluent. In domestic wastewater initial concentration was 280 mg/l. The value is reduced to 20 mg/l in the effluent. In municipal wastewater initial concentration was 380 mg/l. The value is reduced to 50 mg/l. The COD removal efficiency is greater for dairy wastewater as compared to that of domestic wastewater and municipal wastewater.

3.4.4 Nitrogen

Nitrogen values for dairy wastewater, domestic wastewater and municipal wastewater reduced with time but the reduction was higher in the municipal wastewater than in the dairy wastewater and domestic wastewater. The initial values in dairy wastewater, domestic wastewater and municipal wastewater during phytoremediation is 30 mg/l, 70 mg/l and 12 mg/l respectively and these values decreased appreciably to 7.1 mg/l, 14 mg/l and 0.9 mg/l. Nitrogen removal efficiency is greater for municipal wastewater (92.50%) compared with that of dairy wastewater (76.33%) and domestic wastewater (80%).

3.4.5 Phosphorus

Phosphorus was removed from 3.9 mg/l to 0.5 mg/l, 45 mg/l to 2 mg/l, 20 mg/l to 1 mg/l for dairy wastewater, domestic wastewater and municipal wastewater respectively in the treatment. Phosphorus removal may be due to phosphorus intake by the plant. Phosphorus removal efficiency is greater for municipal wastewater (95.56%) compared with that of dairy wastewater (87.5%) and domestic wastewater (95%).

4. CONCLUSION

Experiments were conducted to evaluate the performance efficiency of Azolla pinnata in treating the dairy wastewater, domestic wastewater and municipal wastewater. Several analysis were conducted and results showed that parameters analyzed including pH, turbidity, COD, nitrogen and phosphorus had considerable reduction in their concentrations. Appreciable removal efficiencies were recorded for all parameters under treatment during 30 days. The plant, Azolla pinnata had proven to be very reliable in

treating dairy wastewater, domestic wastewater and municipal wastewater by going through the results obtained. Turbidity and COD removal efficiency is greater for dairy wastewater compared with that of domestic wastewater and municipal wastewater. Even though removal efficiency rate of the parameters such as Nitrogen and phosphorus are slightly greater for municipal wastewater. Azolla pinnata were found suitable enough to grow considerably well in the rectangular trough. Hence, it can be concluded that phytoremediation using Azolla pinnata is ecologically sound and economically viable and it is an attractive alternative to the current cleanup methods. The effluent after phytoremediation is suitable for reuse and recycle along with a yield of Azolla pinnata. This yield can be used to increase productivity. (Azolla pinnata used as cattle feed for high milk production, or it can also be used as a bio-fertilizer for agricultural purpose). This effluents after phytoremediation can be used for irrigation and agricultural purposes. The systems under consideration and values obtained during the experiments were all within acceptable limits of effluents to be discharged into surface water bodies. This sustainable wastewater treatment is associated with low energy consumption, low capital cost and in some situations, low mechanical technology requirements. Hence this project step forward a lead to mutually beneficial system for treatment of wastewater with a yield of Azolla pinnata.

4.1 Scope of the study

Azolla pinnata can be used in phytoremediation in a effective manner. It is very efficient in removing contaminants from dairy wastewater, municipal wastewater and domestic wastewater. Reuse of domestic wastewater, municipal wastewater, dairy wastewater for agricultural uses, irrigation, cleaning, car washing and sewerage uses. The azolla can be used as cattle feed, or feed for other livestock's and can be used as a biofertilizer for vegetable gardens, farm lands, after 30 days this whole treated water can be used as a biofertilizer for paddy cultivation along with Azolla pinnata.

4.2 Limitations

- Initial days of phytoremediation has odor problem.
- Large scale treatment needs higher area for adaptation.

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