BIOLOGICAL TREATMENT OF LAUNDRY WASTE WATER USING PHYCOREMEDIATION TECHNIQUE

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Abstract - *An abundant amount of Laundry Waste Water (LWW) is generated daily and various wastewater treatments have been performed to put into good use. Laundry waste contain soap, soda, detergents and other chemicals for removing stains, oil, grease and dirt from clothing. The present study was undertaken to evaluate the effect of using micro algae such as Chlorella vulgaris and Spirulina for the treatment of LWW. The LWW was collected and treated with algae culture separately. The experiment was conducted for a total duration of 20 days. Samples were periodically (every 5th day) analyzed for physico-chemical parameters such as pH, TDS, TSS, phosphate, nitrate, chloride, sulphate, BOD and COD using standard methods . The removal efficiency of these microalgae has been studied. Chlorella vulgaris shows the best removal capacity of nitrate (81.31%) and COD (85.21%) than spirulina. The Chlorella vulgaris can be used for bioremediation of LWW and the biomass produced can be used as source of renewable energy.*

***Key Words*: Laundry wastewater, Microalgae, Algae culture, Bioremediation, Biomass.**

1. INTRODUCTION

Water is a vital component for the sustainability of life on earth. With an increase in the world population and urbanization, the demand for fresh potable water has also increased .This has accelerated the need for the development of new and more efficient wastewater recycling systems. Laundry wastewater (LWW) can be considered to be relatively less chemically polluted when compared with other industrial effluents; hence its purification and recycling become important in decreasing the demand for fresh potable water. Targeting the development of new and economical treatment methods for LWW should not only be focused towards the efficiency in recycling ability but also incorporate minimal consumption of chemicals and energy. The typical composition of LWW consists primarily of the soap, soda, detergents and other chemicals for removing stains, oil, grease and dirt [5].

Phycoremediation is a type of bioremediation technique that uses macro algae or microalgae for the removal of pollutants including nutrients from wastewater and CO_2 from waste air. Algae are important bioremediation agents and are already being used by many wastewater facilities. The potential for algae in wastewater remediation is wider in scope than its current role. The release of wastewater poses several environmental challenges to the receiving water bodies. This is a global problem that can be solved by the use of microalgae whereby the wastewater is used as feed for micro algal growth. The advantage is that while the microalgae will be removing excess nutrients in the wastewater, there will be concomitant accumulation of biomass for downstream processing [1].

There are number of benefits of growing algae in wastewater as it absorbs nutrient thus reducing the treatment cost of wastewater. Secondly it assimilate large amount of organic carbon to produce its biomass which can further be processed to biodiesel production. Growing algae in wastewater is the most feasible way to reduce the economic and environmental cost of biodiesel production. In addition, wastewater remediation by microalgae is an eco-friendly process with no secondary pollution as long as the biomass produced is reused and allows efficient nutrient recycling [3].

1.1 Objective of the study

- To analyze the performance of using Chlorella Vulgaris and Spirulina for treating LWW.
- To identify the optimum condition for better performance of micro algae in LWW treatment.
- To identify the quality of water through phycoremediation technique.
- To identify the highly efficient method.

2. METHODOLOGY

2.1 Selection of Algae

The algal species used in this study for the treatment of laundry wastewater are Chlorella Vulgaris and Spirulina Platensis, which were bought from store. Chlorella vulgaris shows great potential for capturing carbon dioxide and will grow at a fast rate. It can also grow in extreme environments, high temperatures of 30-35°C and acidic environments such as a pH of 3. Once the algae is used for carbon dioxide consumption, it can be used in a secondary process or product such as animal feed. Spirulina is blue - green algae which are autotrophic and hence the energy requirements to maintain its culture at home are almost nullified. The sunlight that we obtain at our homes is more than adequate for its growth and replication. Mineral replenishment only needs to be supplemented. Spirulina prefers to grow in extreme alkaline medium under sunlight.

2.2 Culture of Algae

Take 2 sterilized buckets and fill half to two-third of the bucket with distilled water. Add the chlorella and spirulina culture into the water in the bucket with a spoon. Also add urea fertilizer as a nutrient for the growth of algae. Place the bucket on a sunny spot inside or near a windowsill. Also attach a thermometer to monitor the temperature of the water in the bucket.

For growing algae at home it is important to provide carbon-dioxide in water. For this, provide aeration by using aerators. Maintain a constant temperature of 25-32ºC, which is very essential for its growth. If sunlight is insufficient use a heat lamp to control the temperature. Finally harvest both the algae culture after 10 days of growth.

Fig -1: Initial stage of culturing

Fig -2: After 10 days of culturing

2.3 Collection of sample

The Laundry Waste water discharged from the washing machine was collected from the laundry pit. It was carefully bottled in a plastic container and was immediately taken to the laboratory for the analysis of physico-chemical parameters such as pH, TDS, TSS, phosphate, nitrate, chloride, sulphate, BOD and COD using standard methods.

2.4 Experimental setup

To study the role of microalgae in laundry wastewater treatment, the following method was employed. Wastewater was treated with culture of Chlorella vulgaris and spirulina platensis.

The algae culture was strained and diluted with 100 ml of distilled water after 10 days of culture. Both the algal culture sample was then added in to 2 bowls separately, containing 3L of laundry wastewater sample to be treated. The experiment was conducted under controlled conditions (Temp 27 ± 2º C) for a total duration of 20 days. Samples were periodically (every 5th day) analyzed for physico-chemical parameters such as pH, TDS, TSS, phosphate, nitrate, chloride, sulphate, BOD and COD using standard methods graph is plotted. Also the removal efficiency was calculated as the percentage removal for each parameter.

3. RESULTS AND DISCUSSION

This section deals with the results and discussion showing promising results of treatment of Laundry waste water using chlorella vulgaris and spirulina platensis.

Table -1: Characteristics of LWW before treatment

Parameters	Initial value
pH	9.7
BOD(mg/l)	520
COD(mg/l)	866
TDS(mg/l)	1992
TSS(mg/l)	42
Phosphate(mg/l)	46
Nitrate (mg/l)	107
Chloride(mg/l)	470
Sulphate(mg/l)	85

3.1 Values of parameters of LWW after treatment with C.Vulgaris

Table 2 shows variation of parameters of LWW after treating with C.vulgaris for duration of 5, 10, 15 and 20 days.

Table -2: Characteristics of LWW after treatment with C.vulgaris

Parameters	After treatment			
	Day 5	Day 10	Day 15	Day 20

pH	9.62	9.28	9.21	9.16
BOD(mg/l)	144	93	59	32
COD(mg/l)	521	321	218	128
TDS(mg/l)	1469	1251	1112	1027
TSS(mg/l)	28	16	9	9
Phosphate(mg/l)	25	16	12	12
Nitrate(mg/l)	56	38	21	20
Chloride(mg/l)	356	322	301	281
Sulphate(mg/l)	59	42	38	34

3.2 Values of parameters of LWW after treatment with Spirulina

Table 3 shows variation of parameters of LWW after treating with Spirulina for duration of 5, 10, 15 and 20 days.

Table -3: Characteristics of LWW after treatment with Spirulina

Parameters	After treatment			
	Day 5	Day 10	Day 15	Day 20
pH	9.53	9.18	9.11	9.06
BOD(mg/l)	324	183	118	113
COD(mg/l)	636	528	412	403
TSS(mg/l)	32	26	18	17
TDS(mg/l)	1617	1378	1274	1188
Phosphate(mg/l)	36	30	23	21
Nitrate(mg/l)	98	82	61	56
Chloride(mg/l)	376	329	302	282
Sulphate(mg/l)	78	53	47	45

Fig -3: C.vulgaris and Spirulina after 5 days of treatment

Fig -4: C.vulgaris and Spirulina after 10 days of treatment

Fig -5: C.vulgaris and Spirulina after 15 days of treatment

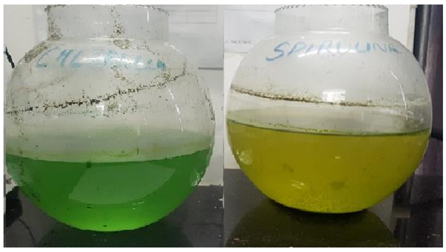

Fig -6: C.vulgaris and Spirulina after 20 days of treatment

3.3 Removal efficiency of treated LWW

Table 4 shows comparison of Removal efficiency of LWW after 20 days of treatment using C.vulgaris and spirulina.

Table -4: Removal efficiency of treated LWW

Parameter	Removal efficiency (%)	
	c.vulgaris	spirulina
BOD(mg/l)	94	78
COD(mg/l)	85	54

TDS(mg/l)	48	40
TSS(mg/l)	79	60
Phosphate(mg/l)	74	54
Nitrate(mg/l)	81	48
Chloride(mg/l)	40	40
Sulphate(mg/l)	60	47

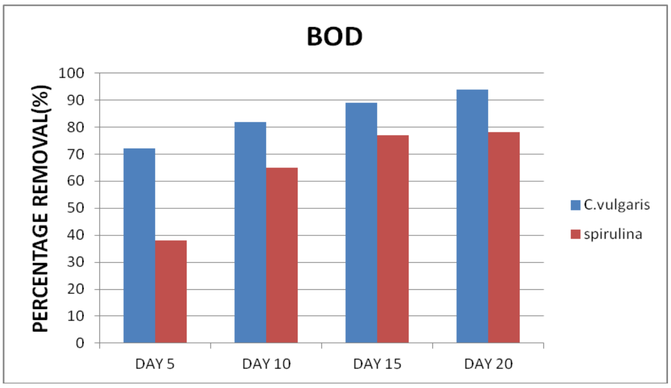

Fig -7: Removal efficiency of BOD using C. vulgaris and Spirulina

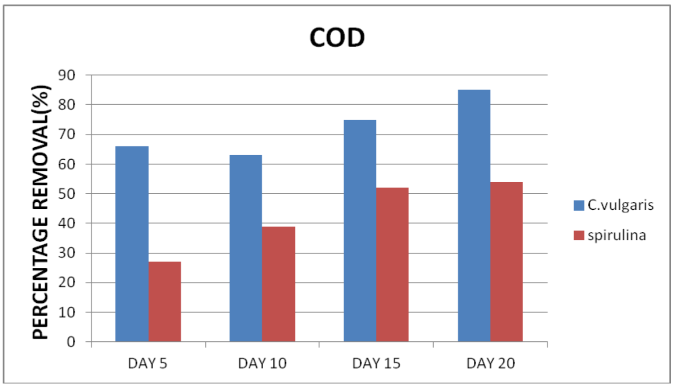

Fig -8: Removal efficiency of COD using C. vulgaris and Spirulina

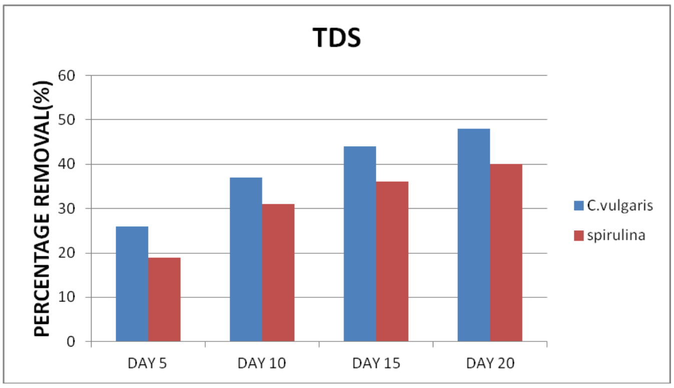

Fig -9: Removal efficiency of TDS using C. vulgaris and Spirulina

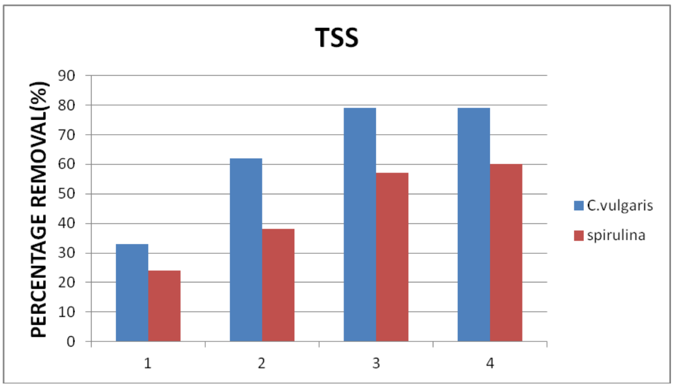

Fig -10: Removal efficiency of TSS using C. vulgaris and Spirulina

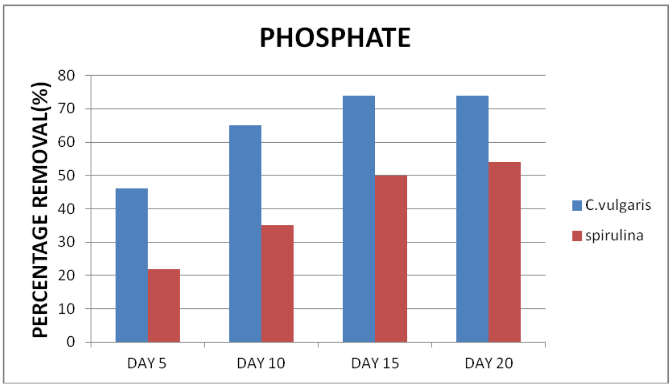

Fig -11: Removal efficiency of Phosphate using C. vulgaris and Spirulina

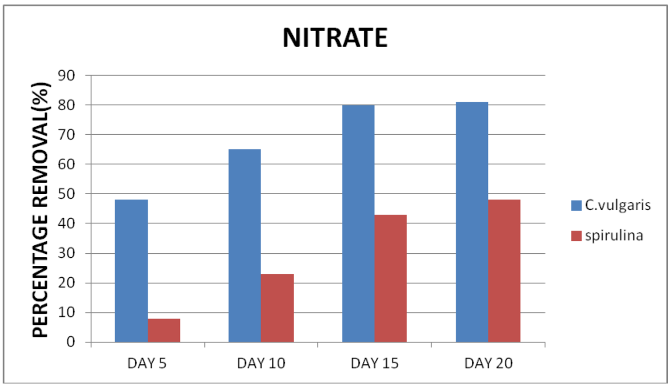

Fig -12: Removal efficiency of Nitrate using C. vulgaris and Spirulina

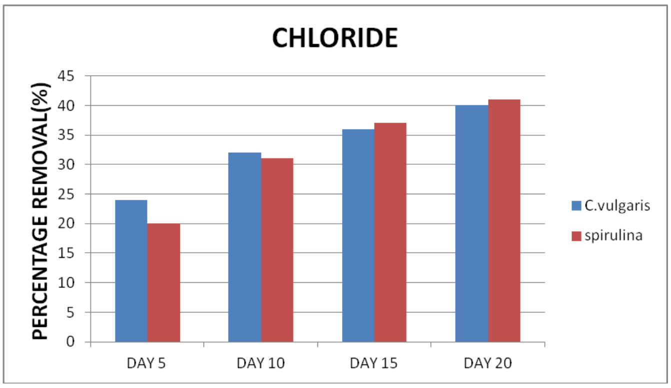

Fig -13: Removal efficiency of Chloride using C. vulgaris and Spirulina

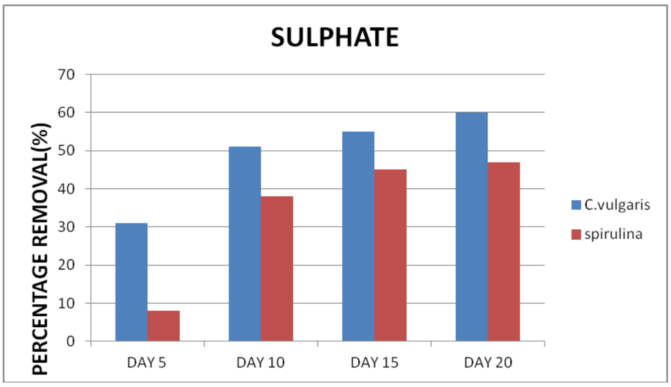

Fig -14: Removal efficiency of Sulphate using C. vulgaris and Spirulina

From the above results and charts it is observed that the maximum removal efficiency of BOD content is observed in treatment system having C.vulgaris. Percentage of removal increases with increasing the days, so maximum removal is seen after 20 days. After treatment, it was reduced to 94 % by C. Vulgaris and 78 % by spirulina. Similar to BOD, the COD concentration is also reduced after the treatment. C. Vulgaris showed the best removal capacity of COD from wastewater after 20 days of treatment.After treatment, the COD level is reduced to 85% and 54% by C. Vulgaris and spirulina respectively. The TDS level is reduced to 48% and 40% up to 20th day by C. Vulgaris and spirulina. Similarly after the treatment the TSS level is reduced to 79% and 60% by C. Vulgaris and spirulina respectively.

After the treatment, C. Vulgaris removed 74% of phosphate in wastewater and for spirulina percentage removal was found to be 54% on 15th day. Percentage of removal increases with increasing the days, so maximum removal is seen after 20 days. Phosphate removal by C. Vulgaris during remediation is due to the utilization of phosphorus for growth. C. vulgaris shows best reduction capacity of nitrate from wastewater than spirulina .The removal of nitrate from wastewater is 81% and 48% when treated with C. vulgaris and spirulina up to 20th day. High levels of nitrogenous compounds in wastewater can be effectively removed by algae. The chloride level is reduced to 40% and 41% by C. Vulgaris and spirulina respectively. Also after treatment, the sulphate level is reduced to 60% and 47% by C. Vulgaris and spirulina respectively.

4. CONCLUSIONS

Experiments were conducted to evaluate the performance efficiency of using Chlorella vulgaris and spirulina for treating laundry wastewater. Several analysis were conducted and results showed that parameters analyzed including pH, TDS, TSS, phosphate, nitrate, chloride, sulphate, BOD and COD had considerable reduction in their concentrations. Appreciable removal efficiencies were recorded for all parameters under treatment for duration of 20 days.

In this study, it is seen that the growth rate of Chlorella vulgaris and spirulina in the laundry wastewater increases by reducing the rate of different pollutants. It is also observed that Chlorella vulgaris removes more nitrates and COD than spirulina .while spirulina shows best result for chloride and TDS removal. Unicellular green algae such as Chlorella and spirulina have been widely used in wastewater treatment as they have fast growth rates and high nutrient removal capabilities. Therefore, it is found that the remediation using Chlorella vulgaris and spirulina of wastewater provides an effective and environmentally acceptable option for wastewater remediation, which is not only recycles valuable nutrients but also improves wastewater quality. Hence it is concluded that the algae treatment is more efficient for small scale treatment in rural areas or communities than conventional methods. In future the removed nutrients or biomass can be utilized for cattle feed, fertilizers and biodiesel production. Also the filtered water can be used for irrigation and agricultural purposes.

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