Feasibility Studies on Growth of Blue Green Algae in Tannery Wastewater for Production of Bio Crude

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Abstract: Biodiesel is a substitute for diesel fuel, which can be extracted from biological sources such as animal fats, seeds, vegetable oils and other industrial wastes. Production of biodiesel from wastes is a novel technique since it results in generation of fuel on par with waste stabilization. Wastes are used as a feedstock for some microorganisms which produce biomass. Then the biomass is converted to energy source like biodiesel. Therefore pollution is avoided by waste reduction and making it into biodiesel which is a potential alternative to petroleum based fuels and plant or animal fat derived fuels. In this study, tannery wastewater was used as a substrate for growing blue-green algae. The tannery wastewater was collected from E. K. M. Leather Processing Company, Erode and characterization of wastewater was done. Chlorella sp. is suitable for the growth in tannery wastewater because of its high salinity. Synthesis of microbial lipid from Chlorella sp. and bio-crude recovery was studied. 40% of its dry weight is of bio-crude, which can be further converted in to biodiesel using trans-esterification. 4.6g/l lipid yield obtained from tannery wastewater in the optimum condition of pH 8 and 250C temperature.

Keywords: Biomolecules, Carbonate, Cyanobacteria, Lipids, Nitrogen, Tannery effluent.

I. Introduction

First generation feed stocks have disadvantage of being used for production of biofuel. These crops for biofuels competes with food demand. Hence, Micro-organisms such as bacteria, yeasts, molds and algae store more lipids in their biomass. Microbial lipid has a lot of similarity to the oil obtained from plants and animals and this similarity is valuable because it can be used for biodiesel production with many environmental benefits. Production of microbial oil is valuable when the cost of production is decreased by optimization of cultivation condition and using low cost substrate. For this study Blue-Green algae cyanobacteria is used for production of biofuel. Cyanobacteria contains substantial amounts of fats and lipids, which are present in the thylakoids and have higher growth rates compared to other micro organisms, which can grow easily in basic nutritional environment. They are able to survive even in high saline waters if supplied with air and light as an energy source and also cultivation is easy. Tannery wastewater is having high nutritional quality and suitable pH for Blue-Green algae growth.

II. Methodology

A. Wastewater Collection

The sample of tannery waste water was collected from E.K.M leather processing company, Erode. The tannery waste water were preserved at temperature lower than 4^{o}C but above freezing point in cold storage chamber to prevent it from undergoing biodegradation due to microbial action. The sample was studied for its characteristics.

B. Algae Collection

Cyanobacteria Chlorella sp. was collected from National Facility for Marine Cyanobacteria (NFMC), Bharathidhasan University, Trichy.

C. Cultivation of Algae

- Microalgae can grow by decomposing Organic and Inorganic matters in tannery effluent with the use of sunlight.
- Algae can act as mini aerators which can increase dissolved oxygen content in effluents in order to make the effluent treated.
- Algae mainly grow with the base of C:N:P ratio. It has the Biomolecules has Carbohydrate, Lipids, Pigments and Proteins.

- 90l of Tannery effluent and 10l of Chlorella Sp. as an inoculum were taken for treatment.

D. Study Parameters

The readings were taken with proper interval. pH, TDS, Conductivity, Salinity, Carbonates, Bicarbonates, Nitrogen, Ammonia, Phosphorous all the readings were taken with one day time interval. And Lipid, Protein, Carbohydrates and Pigment readings were taken with 3 days interval.

III. Results and Discussions

Although there are different species of microalgae present in different forms of water bodies. The bio-mass of algae in wastewater can significantly contribute to the management of wastewater by providing inexpensive, environmental friendly alternative to conventional energy intensive wastewater treatment systems. Use of algae for tannery wastewater treatment is well established and algae based treatment of tannery waste has been investigated. Algal growth in wastewater treatment ponds contributes to treatment mainly through dissolved oxygen production and nutrient assimilation. However, the carbon: nitrogen and carbon: phosphorus ratios in tannery wastewater and lagoon water are low compared to typical ratios in rapidly growing algae biomass.

A. Characteristics of Tannery Wastewater

The tannery waste water was analysed for its characteristics as per standard methods of analysis and the results are tabulated.

Table I: Characteristics of Tannery Wastewater Collected

S. No.	Parameters	Values*
1	pH	8.1
2	Colour	Brown
3	Odour	Unpleasant
4	BOD	2106
5	COD	5440
6	TDS	12230
7	TSS	3137
8	TOC	1762
9	Total Nitrogen	841

*all the values are in mg/l except colour, odour and pH

B. Graphical Results

Graphical variation of all parameters is given below:

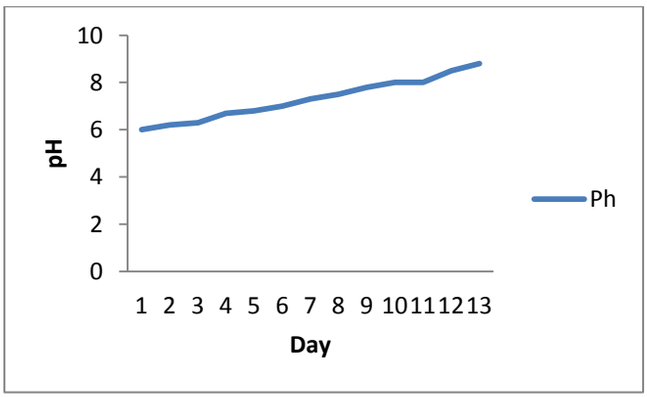

Fig. 1: Variation of pH with Algae Growth

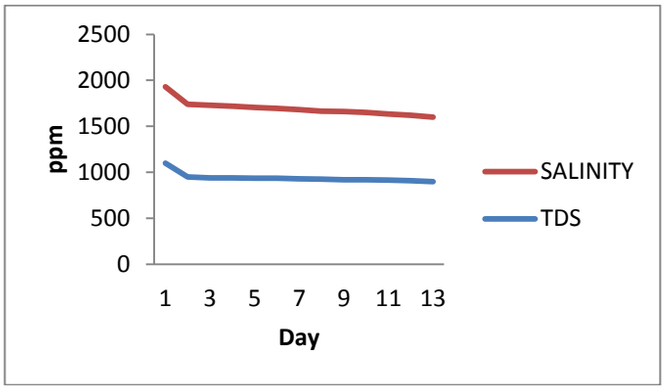

Fig. 2: Variation of TDS and Salinity with Algae Growth

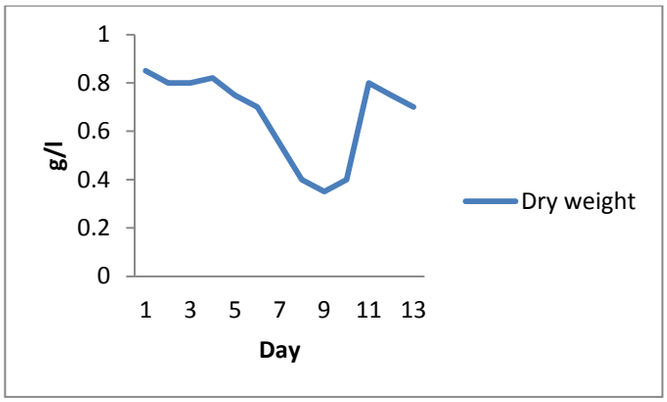

Fig. 3: Variation of Dry Weight with Algae Growth

C. Graphs for Algal Biomolecules

The study on parameters of tannery wastewater sample after inoculation of Chlorella.sp was done. The further study on parameters of sample such as TDS, Salinity, Conductivity, pH were also carried out. It can be observed from above tabulations and figures. The outcome value of the effluent parameters are satisfied the TNPCB standards. The 10 litres of tannery

wastewater was treated. And 46g of slurry obtained from it with the efficiency of 4.6g/l.

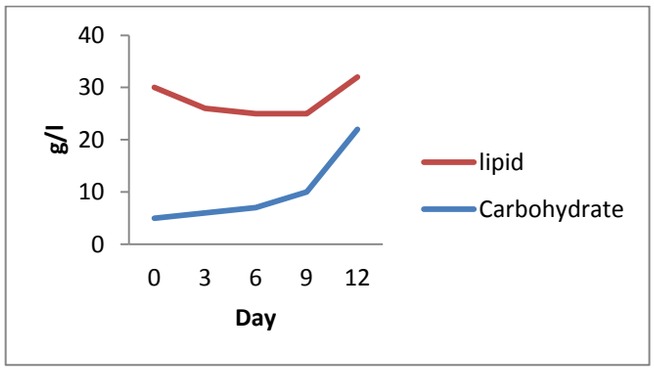

Fig. 4: Variation of Protein with Algae Growth

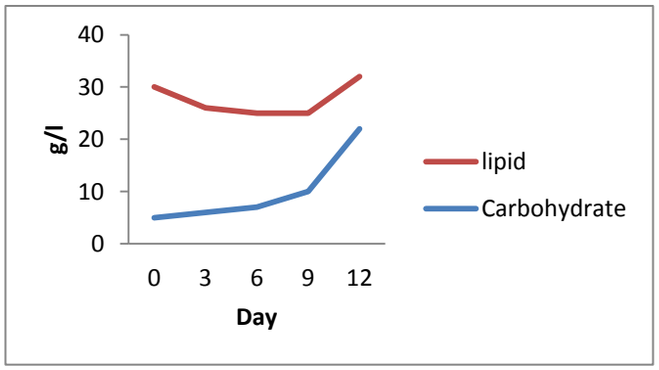

Fig. 5: Variation of Lipid and Carbohydrates with Algae Growth

IV. Conclusion

Tannery wastewater is high strength wastewater which contains more nitrogen and phosphorous, is suitable for lipid production using blue-green algae (marine algae). Chlorella sp. is suitable for growth in tannery wastewater due to its high salinity and helps in the reduction of BOD and COD values. Bio-crude is also recovered from algal biomass. This method is adopted because its advantages in treating the wastewater containing high organic load and Energy recovery by synthesis of biodiesel from microbial lipid. The tannery wastewater is a suitable inoculum for the growth of blue-green algae. Chlorella sp. was more efficient in reducing value of parameters such as TDS, Conductivity, Salinity, pH, COD, BOD present in waste water sample. The recovery of bio crude from algae is an alternative source for producing biodiesel.

References

[1] C. Angerbauer, M. Siebenhofer, M. Mittelbach, and G. M. Guebitz, "Conversion of sewage sludge into lipids by Lipomyces starkeyi for biodiesel production," *Bio resource Technology*, vol. 99, no. 8, pp. 3051-3056, May 2008.

[2] F. Cherubini, "The bio refinery concept: Using biomass instead of oil for producing energy and chemicals," *Energy Conversion and Management*, vol. 51, no. 7, pp. 1412-1421, July 2010.

[3] D. W. Burden, "Guide to the homogenization of biological samples," *Random Primers*, no. 7, pp. 1-14, September 2008.

[4] T. Eevera, and K. Pazhanichamy, "Cotton seed oil: A Feasible oil source for biodiesel production," *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, vol. 35, no. 12, pp. 1118-1128, 2013.

[5] G. Anastopoulos, Y. Zannikou, S. Stournas, and S. Kalligeros, "Transesterification of vegetable oils with ethanol and characterization of the key fuel properties of ethyl esters," *Energies*, no. 2, pp. 362-376, 2009.

[6] J. Janaun, and N. Ellis, "Perspectives on biodiesel as a sustainable fuel," *Renewable and Sustainable Energy Reviews*, vol. 14, no. 4, pp. 1312-1320, May 2010.

[7] L. Balasubramanian, G. Subramanian, T. T. Nazeer, H. S. Simpson, S. T. Rahuman, and P. Raju, "Cyanobacteria cultivation in industrial wastewaters and biodiesel production from their biomass: A review," *Biotechnology and Applied Biochemistry*, vol. 58, no. 4, pp. 220-225, July-August 2011.

[8] S. Lebedevas, A. Vaicekauskas, G. Lebedeva, V. Makareviciene, P. Janulis, and K. Kazancev, "Use of waste fats of animal and vegetable origin for the production of biodiesel fuel: Quality, motor properties, and emissions of harmful components," *Energy and Fuels*, vol. 20, no. 5, pp. 2274-2280, 2006.

[9] X. Liu, X. Piao, Y. Wang, and S. Zhu, "Model study on transesterification of soybean oil to biodiesel with methanol using solid base catalyst," *Journal of Physical Chemistry A*, vol. 114, no. 11, pp. 3750-3755, 2010.

[10] S. N. Naik, V. V. Goud, P. K. Rout, and A. K. Dalai, "Production of first and second generation biofuels: A comprehensive review," *Renewable and Sustainable Energy Reviews*, vol. 14, pp. 578-597, 2010.

[11] P. P. Sethusundaram, K. P. Arulshri, and K. Mylsamy, "Biodiesel blend, fuel properties and its emission characteristics Sterculia oil in diesel engine," *International Review of Mechanical Engineering*, vol. 7, no. 5, pp. 925-929, 2013.

[12] R. E. H. Sims, W. Mabee, J. N. Saddler, and M. Taylor, "An overview of second generation biofuel technologies," *Bioresource Technology*, vol. 101, no. 6, pp. 1570-1580, March 2010.

[13] S. Vajpeyi, and K. Chandran, "Conversion of food-waste into biodiesel through sequential fermentation and enhanced microbial lipid production – A novel platform technology," *Proceedings of the Water Environment Federation*, vol. 2013, no. 16, pp. 2001-2003, 2013.

[14] T. Schneider, S. G. Honninger, W. T. French, R. Hernandez, W. Claupein, W. E. Holmes, and N. Merkt, "Screening of industrial wastewaters as feedstock for the microbial production of oils for biodiesel production and high quality pigments," *Journal of Combustion*, vol. 2012, pp. 1-9, 2012.