Eco. Env. & Cons. 27 (October Suppl. Issue) : 2021; pp. (S273-S277)

ISSN 0971–765X

Comparative assessment of textile wastewater and Ganges water as samples for biodegradation experimental kinetics

Shubhangi Mishra, Pradeep Srivastava*, Virendra Singh and Monika Sharma*

School of Biochemical Engineering, IIT (BHU) Varanasi 221 005, U.P., India
****Banasthali Vidyapith, Banasthali, Rajasthan***

(Received 5 January, 2021; accepted 19 February, 2021)

ABSTRACT

For a healthy living the foremost prerequisite is a clean environment ensuring sustainable treatment along with safe and suitable disposal of the wastewater call for major attention. Being one of the most enormously used natural resources on earth by any living being is water and it will not be an exaggeration stating that a huge quantity of wastewater is generated by any budding community. Not only surface but even pollution of ground water can be caused by raw untreated disposal of wastewater into the environment. Certainly this brings in more serious issue as it gets highly unsafe with the elevating levels of pollution. Eventually numerous developments are coming into picture in the field of wastewater treatment. Moreover, these approaches are coming up with improved effective pollutant removal in addition to exploring sustainable eco-friendly approaches for pollutant removal. The two important red flags on the world map are textile industries and river 'Ganges' making the Varanasi city significant round the globe known for its 'Banarasi Sarees' and 'Holy pilgrimage river' are unfortunately seeking serious immediate help. Various steps used by these manufacturers such as dyeing, fabricating, texturing and finishing stages give out high quantity of chemicals, like binders, acids and salts, etc., undoubtedly adding toxicity to the ecosystem. Here degradation and treatment of the certain harsh color imparting chemicals are being studied subjecting them to two species of microalgae (*Chlorella pyrenoidosa* and *Scenedesmus obliquus*). Nevertheless different modes of biological, chemical and physical methods have been used for textile wastewater treatments, however using microalgae which are easily grown can add upto an economical and eco-friendly approach.

Key words : *Bioremediation, Economically viable, Environmental protection, Sustainable, Pollution toxicology*

Introduction

Textile industries are among one of the most leading industries of India contributing a big financial share to the economy. Extreme amount of reactive oxygen species, leading to cellular peroxidation by algae, may result in chloroplast damage followed by reducing photosynthesis due to inhibition of synthesis of cholorophyll (Cai, Hualing *et al.,* 2020). Most of the industries have already switched their sources of energy towards fuel operated energy power providers in order to fulfull their power requisites for proper running and operation of their treatment plants. However this approach has partialy backed up nonstop power inputs to the manufacturers, on the other hand unfortunately it adds up to the financial liabilities (Maqbool *et al.,* 2016). Be it slaughter or textile industry outlets, research studies performed indicated that algae can be opted not only for biochemical profiling, pollution reduction but

***Corresponding author's email:** *pksrivastava.bce@itbhu.ac.in, viren.biotech@gmail.com, scholarshubhangi.bhu@gmail.com, monica_202005@rediffmail.com

also elevated yield of algal biomass under optimal conditions by *C. pyrenoidosa* (Azam *et al.,* 2020). In order to save small scale textile manufacturers, who are lacking with proper waste management plan, where economic and viable method affordability is the need of the hour, because dumping of such toxic effluents in an untreated form in their local areas is turning out to be risky for the environment (Rahman *et al.,* 2016). Textile wastewater comprises of number of dyes and auxiliary chemicals and consumes a huge quantity of water in one day and in proportion to that results with huge volume of wastewater generated (Khatri *et al.,* 2015). The discharge of textile dye wastewater represents a serious environmental problem and public health concern. In regards to public health concern, the textile wastewater disposal poses a critical environmental toxicology issue. The procedures involved up to the finishing stages of any fabricated product ejaculates chemicals as recalcitrant high in concentration may be biodegradation resistant (Deng *et al.,* 2020). Hence this gives an alarming call to all the researches going around with biological ideas and technology upgradation to control the pollution at this very stage. Besides number of chemicals employed during brightening and softening the texture is also contained by wastewater. Hence, wastewater effluents should be degraded biologically along with procedures which are economically viable favoring environmental protection.

Materials and Methods

Sampling and characterization

Sampling was done by grasp sampling method. The samples were picked up directly from dumping sites of industrial drainage outlets by personal frequent visits onsite. In this method the textile wastewater samples were collected from the discrete textile dye using industries in Varanasi. Ganga water was collected from the Dashshwamedh ghat in Varanasi.

The wastewater samples being picked up onsite by grab sampling method were characterized for different parameters by standard protocols from APHA. There are various parameters being followed for respective parameters (Table 1)

Table 1. Methods followed for different parameters in characterization of wastewater

S.N.	Parameter	Method
1.	Colour	Visual comparison
2.	pH	pH meter
3.	Temperature	Thermometer
4.	Phenol	Direct photometric method
5.	Dissolved oxygen	Membrane electrode method
6.	Total Hardness	EDTA Titration method
7.	BOD	Titrimetric method
8.	COD	Open reflux method
9	Alkalinity	Titration with H_2SO_4
10.	Chlorine	Iodometric method
11.	Total solids	Evaporation based method
12.	Total dissolved solids	Evaporation based method
13.	Turbidity	Colorimetric method
14.	Nitrogen	Nesslerisation method

B. Culturing of microalgae

Two most suitable microalgal strains were being studied over *Chlorella pyrenoidosa and Scenedesmus obliquus,* were cultured in Bold's basal medium believed to suitable for microalgal growth, further subjected to wastewater as their nutritional medium.

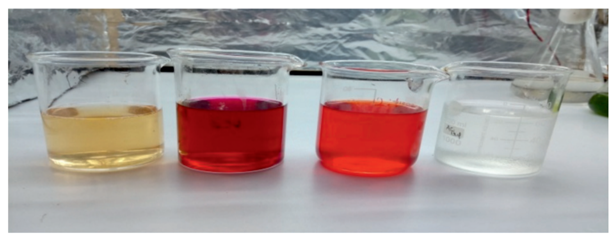


Fig. 1. Wastewater taken as samples 1. Acid Yellow 2. Acid Pink 3. Acid Orange 4. Ganga Water

Optimization of growth of microalgae

For acclimatization inoculums were transferred into textile wastewater 100 ml (50% v/v in water) later acclimatized algae were transferred to 500ml of wastewater samples. In this study Nitrogen source, Carbon source and wastewater % is the varying parameter and used for the optimization of growth and successively better yield of biomass.

Treated wastewater characterization

The wastewater samples were characterized again after treatment for the same parameters in the same pattern, which were studied prior treatment for comparable analysis.

Observation

Growth optimization

Numerous aspects with respect to design of production and treatment of wastewater using microalgae for bioremediation of wastewater and biodiesel production are being optimized.

Nitrogen Source optimization

Nitrogen being optimized as a source for the two species and also by using urea as a nitrogen source for *Chlorella pyrenoidosa* and *Scenedesmus obliquus*.

(a) (b) (c)

Fig. 4. Nitrogen Source optimization in (a) *Chlorella pyrenoidosa* (b) *Scenedesmus obliquus* (c) Urea as Nitrogen

C. Carbon Source optimization

Carbon Source optimization was performed for *Chlorella pyrenoidosa* and *Scenedesmus obliquus.*

Fig. 5. Carbon Source optimization for Chlorella pyrenoidosa and Scenedesmus obliquus.

Results and Discussion

Characterization of Wastewater

The intense colours of the dyes are significantly reduced after treatment with microalgae indicating decolourisation as a visible integral part of bioremediation.

Table 3. Growth curve and growth constant for the

Day	*Chlorella pyrenoidosa*	
	Biomass Conc. (g/L)	Optical density (680 nm)
0	0.513595	0.068
1	0.574018	0.076
2	0.70997	0.094
3	0.785498	0.104
4	1.261329	0.167
5	2.167674	0.287
6	3.413897	0.452
7	4.244713	0.562
8	5.15861	0.683
9	5.702417	0.755
10	6.049849	0.801
11	6.200906	0.821
12	6.231118	0.825

The analysis of pollution parameters including COD, ammonia, colour and phosphorus were accomplished at the commencement as well as at the end of the run with respect to the methodology described in APHA (2000).

The growth curve is explained in the figure in which lag phase occurred for 3 days and log phase occurred for 7 days for the *Chlorella pyrenoidosa.* The growth rate constant and maximum growth rate constant can be calculated as:

growth constant (μ)= $\ln (X_f/X_0)/(t_2-t_1) = \ln (6.23/0.51)/12=0.21$g/L/day

maximum growth rate constant (μ_{max}) = $\ln (6.2/0.78)/7=0.29$g/L/day

Standard curve of *Chlorella pyrenoidosa* is explained below:

Table 2. Table showing characterization of various parameters textile wastewater samples and Ganga river sample

S. N.	Parameter	Yellow (acid) dye	Orange (acid) dye	Pink (basic) dye	Ganga river water
1.	Colour (660nm)	Yellow	Orange	Dark Pink	Transparent
2.	pH	8.0	8.1	8.1	7.6
3.	Temperature	34 °C	36 °C	37 °C	28 °C
4.	TSS	58 mg/L	40 mg/L	69 mg/L	178 mg/L
5.	TDS	115 mg/L	132 mg/L	127 mg/L	206 mg/L
6.	Biological Oxygen Demand	30.0mg/L	70.2mg/L	36.4 mg/L	47.3 mg/L
7.	Chemical Oxygen Demand	297mg/L	275mg/L	289 mg/L	322mg/L
8.	Total organic carbon	149 mg/L	139mg/L	145mg/L	164mg/L

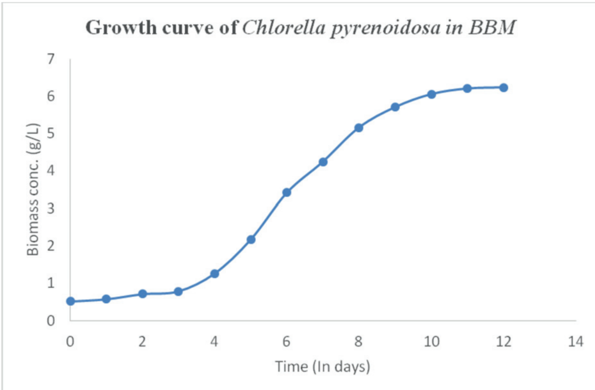
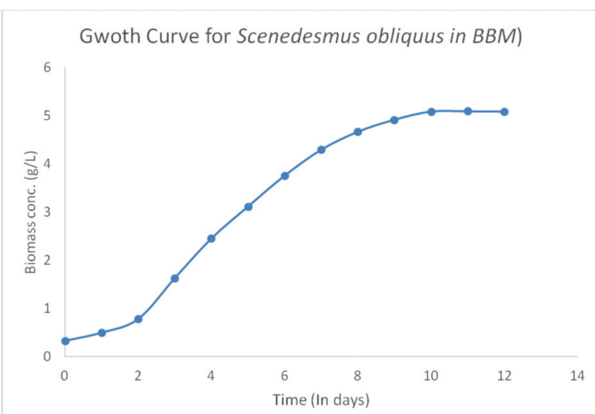


Table 4. Growth curve of *Scenedesmus obliquus*

Biomass Conc.(g/L)	Optical density (680nm)
0.5	0.088
1	0.132
1.5	0.192
2	0.263
2.5	0.324
3	0.388
3.5	0.456
4	0.514
4.5	0.598
5	0.688



The growth curve is explained in the figure in which lag phase occurred for 2 days and log phase occurred for 7 days for the *Scenedesmus obliquus.* The growth rate constant and maximum growth rate constant can be calculated as:

growth constant (μ)= ln $(X_f/X_0)/(t_2\text{-}t_1)$ = ln (5.081/ 0.317)/12=0.23 g/L/day maximum growth rate constant (μ_{max}) = ln (4.91/0.77)/7=0.265g/L/day

Conc

Along with textile wastewater (dyes) taken as samples, water sample from the river 'Ganga' was subjected to two robust microalgae species (*Chlorella pyrenoidosa* and *Scenedesmus obliquus*) as their growth medium where optimum growth condition was developed (Urea-0.5 g/L, wastewater- 50% v/v). The reduction efficiency of decline in Chemical Oxygen Demand, Nitrogen-Nitrate, Ammonia-Nitrogen, Phosphate-P, and Dye(color) removal for *Chlorella* and *Scenedesmus* sp. is 80-90%, 70-80%, 95-99%, 67-77% and 65- 75 % respectively.

Acknowledgements

We gratefully acknowledge Head and Mentor, School of Biochemical Engineering, IIT BHU, DST (WOS-B), MHRD and BHU for providing funds and research facilities, bringing this research work into fruition.

Funding

This work was supported by Ministry of Science and Technology, Department of Science and Technology, Women Scientist Scheme – B (Ref no. DST/WOS-B/ 2017/287-AAS)

References

Azam, R., Kothari, R., Singh, H. M., Ahmad, S., Kumar, V. A. and Tyagi, V. V. 2020. Production of algal biomass for its biochemical profile using slaughterhouse wastewater for treatment under axenic conditions. *Bioresour. Technol.* 123116.

Cai, H., Liang, J., Ning, X. A., Lai, X. and Li, Y. 2020. Algal toxicity induced by effluents from textile-dyeing wastewater treatment plants. *J. Environ Sci.* 91 : 199-208.

Cardoso, N. F., Lima, E. C., Royer, B., Bach, M.V., Dotto, G. L., Pinto, L. A. and Calvete, T. 2012. Comparison of *Spirulina platensis* microalgae and commercial activated carbon as adsorbents for the removal of Reactive Red 120 dye from aqueous effluents. *J. Hazard Mater.* 241: 146-153.

Chia, M. A. and Musa, R. I. 2014. Effect of indigo dye effluent on the growth, biomass production and phenotypic plasticity of *Scenedesmus quadricauda* (Chlorococcales). *An. Acad. Bras. Ciênc.* 86(1) : 419-428.

Deng, D., Lamssali, M., Aryal, N., Ofori Boadu, A. Jha, M. K. and Samuel, R. E. 2020. Textiles wastewater treatment technology: A review. *Water Environ Res.* 92(10) : 1805-1810.

Kassim, M. A. and Meng, T. K. 2017. Carbon dioxide (CO_2) biofixation by microalgae and its potential for biorefinery and biofuel production. *Sci. Total Environ.* 584 : 1121-1129.

Khatri, A., Peerzada, M. H., Mohsin, M. and White, M. 2015. A review on developments in dyeing cotton fabrics with reactive dyes for reducing effluent pollution. *J. Clean Prod.* 87 : 50-57.

Khoo, C. G., Lam, M. K. and Lee, K. T. 2016. Pilot-scale semi-continuous cultivation of microalgae *Chlorella vulgaris* in bubble column photobioreactor (BC-PBR): hydrodynamics and gas–liquid mass transfer study. *Algal Res.* 15 : 65-76.

Maqbool, Z., Hussain, S., Ahmad, T., Nadeem, H., Imran, M., Khalid, A., Abid, M. and Martin-Laurent, F. 2016. Use of RSM modeling for optimizing decolorization of simulated textile wastewater by *Pseudomonas aeruginosa* strain ZM130 capable of simultaneous removal of reactive dyes and hexavalent chromium. *Environ. Sci Pollut Res.* 23 (11) : 11224-11239.

Pérez, L. 2016. Biofuels from microalgae, a promising alternative. *J Pharm Chem Anal.* 2 : 103.

Rahman, M. A., Mizanur, M. and Mubarak, A. 2016. Scope of reusing and recycling the textile wastewater after treatment with gamma radiation. *J. Clean Prod.* 112 (1137) : 3063-3071.

Randrianarison, G. and Ashraf, M. A. 2017. Microalgae: a potential plant for energy production. *Geology, Landsc. Ecol.* 1(2) : 104-120.

Taneja, N. Ray, S. and Pande, D. 2016. India-Pakistan trade: Textiles and clothing (No. 326). Working Paper. 1-37.