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Research Paper

Treatment of Tannery Effluent using Cyanobacterium (*Lyngbya Sp.*) with Coirpith

Microbiology

KEYWORDS : Coir pith, Tannery effluent, Decolorization, *Lyngbya sp.*

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ABSTRACT

Aim of the present investigation was to evaluate the treatment of tannery effluent using marine cyanobacterium (Lyngbya sp.) with coir pith. The physicochemical parameters such as pH, OD, EC, COD, BOD, TDS and chloride content and removal of heavy metal such as mercury, chromium, cadmium, Iron, copper and lead was monitored on 14th day intervals of incubation. Growth was monitored by Chlorophyll a level and protein content analysis which was increased in combined treatments when compared to individual such as physical (coir pith) and biological (Lyngbya sp.) treatment process.

INTRODUCTION

Tannery effluent is among one of the hazardous pollutants of industry and the major problems are due to the presence of heavy metals, toxic chemicals, chloride, lime with high dissolved and suspended salts and other pollutants (Uberai, 2003). Tanneries generate wastewater in the range of 30-35 L/kg skin/hide processed with variable pH and high concentrations of suspended solids, BOD, COD, tannins including chromium (Nandy et al., 1999). The growth of industrialization has encroached even to small townships and villages along with all hazards of pollution.

Coconut (Coccus nucifera L.) is one of the most useful extensively cultivated palms in tropical countries such as India. The waste products of coir yarn industry are coir dust and coir pith or coco peat which constitute about 70% of the husk. In spite of their limited use as soil conditioners, the quantity of coir dust produced is so enormous making its disposal difficult because of its lignocellulosic nature and slow degradation in the natural environment (Malliga et al., 1996).

Cyanobacteria are photoautotrophic microorganism and inexpensive to maintain with high growth potential. High biomass and utilization potential are highly suitable for bioremediation process (Subramanian and Uma, 1996).

Biological treatment of tannery effluent process is carried out to overcome environmental pollution. Cyanobacteria and coir pith in the tannery effluent would be an ideal absorbent/adsorbent to remove heavy metals and other minerals. Hence, the present study is to investigate the growth of cyanobacterium along with coir pith and decolorization of tannery effluent.

MATERIALS AND METHODS

Collection and characterization of tannery effluent

Tannery effluent sample was collected from a tanning industry in Sempattu near Bharathidasan University, Tiruchirappalli, Tamil Nadu, India.

Organism and Source

Cyanobacterial strain Lyngbya sp. was obtained from the germplasm collections of National Facility for Marine Cyanobacteria (NFMC), Department of Marine Biotechnology, Bharathidasan University, Tiruchirapalli, Tamil Nadu, India.

Laboratory cultivation of Lyngbya sp.

In a series of 250 ml conical flask, auxenic cyanobacterial culture was inoculated in 100 ml of sterile ASN III medium and incubated under white fluorescent light of 1500 lux at 25±2ºc for a period of 14/10 hrs. dark /light cycle.

Physiochemical characteristics of Tannery waste water

All the parameters were determined based on standard methods (APHA, 1998). The pH was determined by pH meter (Potential metric method), EC was measured by a conductivity meter (Rayment and Higginson, 1992), color was assayed at wavelength 580nm by (Colorimetric method), BOD, COD and Cl_2 concentrations were measured according to standard methods (APHA, 1992), total dissolved solids (TDS) using filtration method (Valentine, 1996), heavy metals measured by flame atomic absorption, (AOAC) Atomic absorption spectrometric method, Chlorophyll (Mac Kinney, 1941) and Protein (Lowry et al., 1951) by spectrophotometric method.

Statistical analysis

The effect of each parameters was studied in triplicate and the data were graphically presented as the mean ± S.D. of triplicates (n=3).

RESULT AND DISCUSSION

Effluent samples were analyzed for the color reduction before and after treatment with coir pith and cyanobacterium Lyngbya sp. and (Plate 1) showed comparisons between the raw and treated effluent on 14^{th} day analysis.

Plate-1. Effect of coir pith and Lyngbya sp. in tannery effluent on 14^{th} day

TN = Tannery effluent; CP = coir pith; CB = cyanobacterium

A change in color of the effluent was an initial indication of decolorization period. The initial effluent was dark brown in color and on 14th day treatment with coir pith exhibited light brown in color. Cyanobacterium (Lyngbya sp.) treated effluent showed light green in color, surprisingly, colorless medium was observed in combined treatment (coir pith and Lyngbya sp.). This could be as a result of combined action of coir pith and cyanobacterium during treatment process.

Lyngbya sp. grow well in ASN III mesium, in the present study, the substitutes of tannery effluent acted as the nutrient for the growth of cyanobacterium and reduced the concentration of

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color during degradation and decolorization period. Supporting evidences showed that cyanobacterial interaction with tannery effluents effectively decreased their color intensity (Nantha et al., 2010). Durai et al. (2011) reported that in a Sequential batch bioreactor; color removal efficiency using mixed culture was obtained from the secondary sludge of tannery effluent.

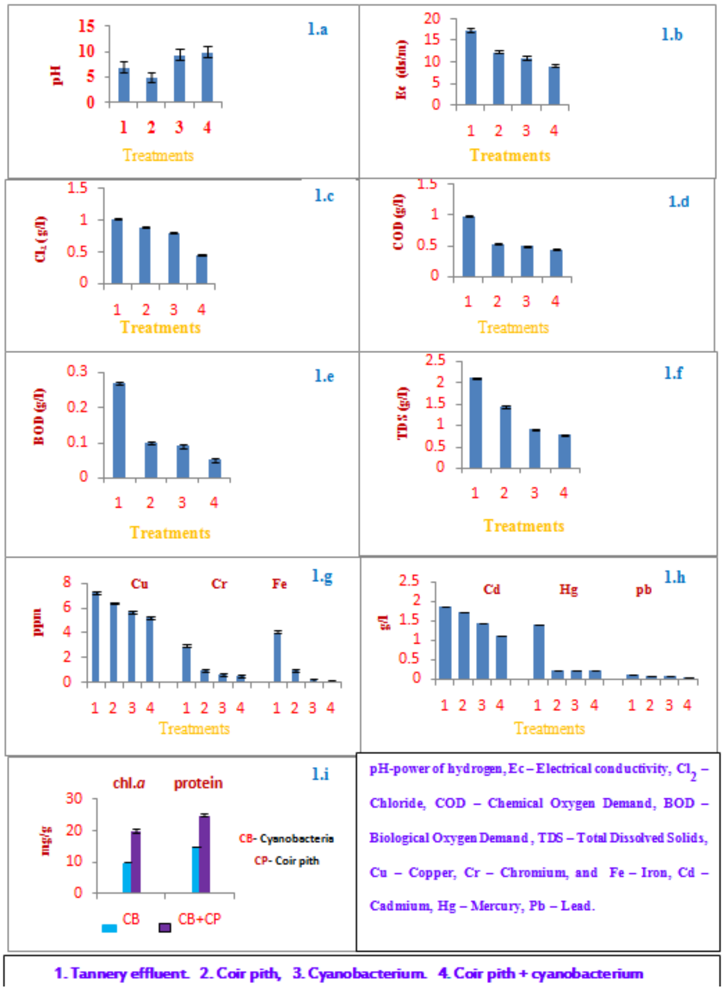
Physico chemical parameters

Physico chemical parameters analyzed in raw tannery effluent, treatment with coir pith and Lyngbya sp. individualy and the combination of coir pith along with Lyngbya sp. (Fig.1a-i).

Reductions of all the parameters in physical, biological and combined treatments were exhibited on 14^{th} day. Combined treatment efficiently removed color and all the physicochemical parameters (Fig.1a-h). The pH of tannery effluent control was alkaline, but, showed reduction with coir pith treatment. With cyanobacterium as well as combined treatment, pH level was increased and obstinated in alkaline condition. Reports confirmed pH of the effluents varied between 7.1 and 9.2 during cell growth, which is similar to the natural variations in seawater, indicating no significant precipitation of heavy metals by alkalinization (Matsunaga et al., 1999). At the end of phycoremediation using Chlorella vulgaris i.e., on day 7, pH of the effluent increased from 7.6 to 8.0 and was maintained (Hanumantha et al. 2011). The initial pH of the chrome tan (7.01) gradually increased to 7.79 on 45th day (Jayabalakrishnan et al., 2009).

Tannery effluents were initially characterized with a high electrical conductivity and after treatment a satisfactorily decrease on 14th day was noticed in all treatments Supporting evidences showed that the high electrical conductivity does not affect cyanobacteial activity during bioremediation of tannery

Fig.1. Reduction of Physico chemical parameters and growth factor of Lyngbya sp. on 14^{th} day in treated tannery effluent.



On the contrary Santamaria- Romero and Ferrera cerrato (2001) reported that the salt concentration above 8.0 dsm/L negatively affected the microbial population as well as biotransformation of organic matter.

The chloride, BOD, COD and TDS (Fig. 1c-1f) content were found to be reduced in all the treatments but significant reduction was observed only with the combined treatment. Chloride was introduced to tannery effluents from large quantities of sodium chloride used in hide and skin preservation or pickling process. Certain bacteria and fungi are often sensitive to higher levels of these salts which cause their cellular break down. On the other hand, negligible effect of salts is found over cyanobacteria as it prefers to grow in salt medium (Nantha et al., 2010). In Parthenium sp. dried biomass is capable of achieving up to 40% reduction in chloride content at lab scale (Apte et al., 2011). Chlorella vulgaris induced progressive reduction in both COD and BOD values of the effluent and this could be attributed to the high algal growth rate and intense photosynthetic activity (Colak and Kaya, 1988). Duangporn et al. (2005) identified the reduction of Chemical oxygen demand in tannery effluents from 7.328 g/L to 3.371 g/L after inoculation of Rhodopseudomonas blastica. It was found that the BOD was reduced from 4.967 g/L to 1.010 g/L in tannery effluent.

TDS concentration also decreased from 25.264 g/L to 20.788 g/L (17.72% removal) by the extended aeration period of 24 hrs. (Khan, 2005). Nantha et al. (2010) also reported that TDS was almost reduced to half its original concentration after the cyanobacterial treatment i.e. from 2.200 g/L to 1.130 g/L on the final day of treatment.

All heavy metals were found to be reduced with all the treatments notably with the combined treatment of Lyngbya sp. with coir pith in tannery effluent (Fig. 1g-1f) due to adsorption and absorption of heavy metal particles on the surface of Lyngbya sp. treatments along with coir pith. Supporting evidences showed that during this experiment 95.4% of Cd, 97.7% of Fe, were removed by the Nostoc sp. From this experiment, Nostoc sp. showed high efficiency to remove the heavy metals (Srikumaran et al., 2011). Removal of heavy metals by biosorption technique using fungi have been employed to remove metals such as Cd, Cu, Fe, and Pb from aqueous solutions in tannery effluent (Ahluwalia and Goyal, 2007). Bacillus spp and Staphylococcus spp. showed excellent ability to reduce hexavalent chromium to non toxic trivalent chromium, i.e. 95% in tannery effluent treatment (Mythili and Karthikeyan, 2011). Razaee et al. (2006) achieved 90% adsorption of Hg by Spirogyra spp. within 15 min and equilibrium reached at 30 min. In general, potential microorganism especially bacterial species can remove heavy metals from solutions by biosorption or bioaccumulation or both. A variety of mechanisms exist for the removal of heavy metals from aqueous solution by bacteria, fungi, ciliates, algae, mosses, macrophytes and higher plants (Pattanapipitpaisal et al., 2002; Rehman et al., 2008). Biological process is a promising technique for removal of molecules with different physicochemical properties since it uses specific microorganisms potentially capable of biodegradation (Faouzi et al., 2013).

GROWTH ASSESSMENT STUDY

Chlorophyll a is a pigment which is present in cyanobacteria due to the activity of photosynthesis and it plays a significant role in electron transport system and this is an important factor for growth analysis. Algal cultures are influenced by a variety of environmental factors and they play a significant role in the production and composition of the photosynthetic pigment (Kannan et al., 2012).

In growth assessment study, chlorophyll a and protein content was studied. Lyngbya sp. with coir pith treatment showed enhancement of chlorophyll a and protein contents on 14^{th} day when compared to only Lyngbya sp. alone (Fig 1.i). This could be due to the absorption of nutrients from tannery effluent and degradation of coir pith by Lyngbya sp. The growth of a cyanobacterium namely Anabaena azolla ML2 with coir pith showed an increase on growth rate in terms of chlorophyll a (Malliga et al., 1996). Similarly, Oscillatoria latevirens grown with Prosopis juliflora with different particle size and ratio showed a higher amount of chlorophyll a content when compared to the control (Prabha et al., 2005). Malliga et al. (2012) reported that the chlorophyll a and protein content of cyanopith was found to be increased when compared to control (Oscillatoria annae). Treatment of cultures Anabaena sp. with 8ppm showed higher chlorophyll content in tannery effluent (Kannan et al., 2012). It was also reported that when effluent was diluted 10 times with the sterile medium and supplied to the cultures of Tolypothrix tenius it enhanced protein levels of cells over control cultures. The protein concentration of cyanobactria was found to be 118.0 mg/g. The cyanobacterium when decomposed the coir pith the content of when decomposed was measured as 148.0 mg/g (Henciya et al., 2013).

CONCLUSION

Tannery industries produce large amounts of waste water and release directly to the water bodies near to industries thus polluting the environment. Tannery effluent treatment before discharge is important to reduce the environmental damage. In the current study, the performance of waste water treatment and removal of heavy metals and physiochemical parameters were observed on 14th day. So, the tannery effluent inoculated with Lyngbya sp. along with coir pith showed significant results in the removal of color and heavy metals when compare to all other individual treatments and control.

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