Treatment of Coir Retting Liquor by Natural Biopolymer

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Abstract

Coir is the essential product obtained from retting of coconut husk. Coir making is the traditional method practiced only in the Kanyakumari district. Coir dusts left from the extraction of coir fiber are used in agricultural purposes for their fertility and water holding capacity. During fiber extraction, retting units released the effluent called retting liquor. Retting liquor is dark brown, creating foul smell, H_2S and anoxic condition and is directly discharged into the Manakudy estuary and causes organic enrichment. Continuous and intensive exploitation of backwaters by retting liquor led to the transformation of productive water bodies into 'hot spots' of pollution. Adsorption is the appropriate method to remove organic pollutants from retting liquor. Chitosan is a bio-adsorbents used to treat the retting effluents. After treatment, colour is changed, increases the oxygen level from anoxic to 1.49mg/lit. Nutrients, BOD and COD were significantly reduced from above permissible limit to permissible limit.

Keywords: *Retting liquor, Estuary, anoxic, Hot spots, adsorption and Chitosan.*

1. Introduction

Water is a life sustaining drink and is essential for the survival of all living organisms. Kanyakumari district is gifted with a large number of water bodies including seas, estuaries and irrigation ponds. These water bodies are essential for the conservation of biodiversity and play a pivotal role in the cycling of energy in aquatic ecosystem (Verma *et al.,* 1994; Sharma *et al.,* 2007 and Ahila Angelin *et al.,* 2010). Nowadays, these water bodies are polluted and contaminated mainly by various anthropogenic activities. Retting liquor coming from coir making industry is the main anthropogenic activity causes pollution in backwater. Coir making industry is one of the most well organized cottage industries in Kanyakumari district of Tamilnadu, offering direct employment opportunity to majority of the people. Approximately 60 coir retting units are situated along the Manakudy estuary. It is the first estuary in the Southwest Coast of Peninsular India, which is located 4 km west of Kanyakumari. Coir retting is a process of decomposition of coconut husk by the action of bacteria. Coconut husk is deeply immersed in the retting yards for about 90-120 days. Retting leads to the dissociation of the major constituents from mesocarp-pectin, hemicelluloses, cellulose and tannin. These retting units directly discharge their retting effluent in to the estuary without any treatment. Retting effluent is dark brown; create foul smell, enriched with organic matter, H_2S, anoxic condition and turbid nature. Retting effluents deteriorate physicochemical and biological qualities of water. Continuous and intensive exploitation of backwaters by retting liquor led to the transformation of productive water bodies into 'hot spots' of pollution. Therefore, there is a critical need to develop an efficient and economic treatment for retting effluent, before its discharge into natural resources. Aim of the present study was planned to treat retting effluents in an eco-friendly manner. One of the most commonly used wastewater treatment techniques is adsorption, which is the physical adhesion of chemicals onto the surface of a solid. Biopolymers are being used for adsorption mainly because cheap resource. Chitosan has been used as adsorbents to treat retting effluents. Chitosan is extracted from crustacean shells. It is (2-acetamido-2-deoxy-β-D-glucose-N-acetyl glucosamine) prepared from chitin by deacetylation with a strong alkaline solution. Chitosan is biodegradable, biocompatible and nontoxic (Varma *et al.,* 2004). Chitosan has the potential to reduce and solve some environmental pollution for the creation of a "green environment". Chitosan is a renewable polymer, which undergoes natural decomposition, has no side effects or allergic effects if implanted in the body.

2. Materials and methods

2.1. Experimental design and methods

Retting effluent was collected from the retting units nearer to the Manakudy estuary, Kanyakumari District. The collected retting liquor was safely transported to the laboratory and stored at 4^0C for further analysis. Physico-chemical parameters such as color, odour, pH, BOD, COD, Calcium, chloride, magnesium, manganese,

potassium, iron, nitrite, nitrate, fluoride, phosphate, sodium and sulphate were analyzed using standard method (APHA, 2005). After the characterization of the retting liquor it was subjected to treat with chitosan.

2.1.1 Coagulant preparation

Chitosan powder is obtained from Tutucorin Fisheries College and further experimental setup was carried out in the Laboratory. Stock solution of chitosan should be prepared before starting the experiment. Powder is soluble in dilute acetic and hydrochloric acids. One hundred milligrams of chitosan powder was accurately weighed into a glass beaker and mixed with 10 ml of 0.1 M acetic acid solution and kept aside for about an hour to dissolve completely. It was then diluted with 100 ml of water to obtain a solution containing 1.0 mg chitosan per ml of solution. The purpose of addition of acetic acid is because of chitosan dissolved in acetic acid was used in the coagulation and flocculation processes. Chitosan is soluble in acidic solution, which makes it more available for application. Therefore, acetic acid needs to be added in order to dilute the chitosan powder. After the addition of distilled water to chitosan powder, there is no solubility of chitosan powder in water was observed.

3. Result and Discussion

3.1. Physicochemical characters of raw retting liquor

Raw retting effluent was dark brown with pH 9.5. It created foul smell and anoxic condition. BOD and COD of the effluent were found to be 90.6mg/l and 423.4 mg/l respectively. Calcium, chloride, magnesium, manganese, potassium, iron, nitrite, nitrate, fluoride, phosphate, sodium and sulphate were 476.2mg/l, 3443mg/l, 455.7mg/l, 0.71, 107.2mg/l, 4.95mg/l, 2.82mg/l, 11.8mg/l, 1.13mg/l, 4.5mg/l, 1115.4mg/l and 135mg/l respectively. Similar results have been reported by Helen *et al.,* (2011) Kasthuri *et al.,* (2011) and Ancy Jenifer *et al.,* (2014).

Table 3.1 : Physicochemical characteristics of raw retting effluent and treated retting water with chitosan

S.No	Parameters	Permissible limit	Agency	Raw retting effluent	Treated retting water
1	Colour	-	-	Darkbrown	colourless
2	DO	5	ISI	0	1.49
3	pH	6.5-8.5	WHO	9.5	7.38
4	BOD	5	ICMR	90.6	19.6
5	COD	200	WHO	423.4	102.5
6	Calcium	200	CPHEEO	476.2	90.3
7	Chloride	250	WHO	3443	624
8	Magnesium	100	BIS	455.7	44.7
9	Manganese	0.1	WHO	0.71	0.21
10	Potassium	12	WHO	107.2	58
11	Iron	0.3	WHO	4.95	2.05
13	Nitrite			2.82	0.12
14	Nitrate	45-100	WHO	11.8	9.48
15	Fluoride	1.5	WHO	1.13	0.55
16	Phosphate,	0.5-1.0	WHO	4.5	0.55
17	Sodium	200	WHO	1115.4	310
18	Sulphate	150	WHO	135	25.07

Almost all the physicochemical parameters examined in the retting effluent have been found to be very high and well above the permissible level prescribed by standard organizations (table 3.1). It makes the water was unsuitable for domestic purposes, drinking, and recreational purposes and also affects the photosynthetic activity in aquatic life. Dark brown colour may be due to the presence of lignin and minerals such as iron and manganese. Color tests indicate the need for water treatment. Foul smell is caused by the chemical agents like H_2S, humus, free chlorine, ammonia, phenols, alcohols, esters, phosphorus and biological agents such as fungi and microorganisms. Present result was confirmed by Ancy Jenifer *et al.,* (2014), Thamaraiselvi *et al.,* (2014), Vasanthy *et al.,* (2007) and Arslan, (2000). pH measures the hydrogen ion concentration in water. pH also affect the rate and survival of biological organisms. Chloride is generally found in salt water and it is an inorganic anion compound in retting liquor. High chloride content affects the metallic pipes and agriculture crops. Sulphates represent the hardness of

water and alter the pH. Phosphates at lower concentration are non-toxic to living organisms. High level of phosphate in water causes digestive problems (Nese Tufekci, 2007). COD and BOD were higher than O_2 since the BOD and O_2 are interlinked. Anoxic condition and high amount of BOD may be due to increased decomposition of organic matter by microorganism results in the utilization of dissolved oxygen, production H_2S and which eventually led to a state of anoxia. Similar result was found by Mishra, (1996). After the treatment of retting liquor with chitosan, significant changes have been observed in the retting water. Dark brown color was changed; absence of foul smell, amount of oxygen increased from anoxic condition to 1.49 mg/lit and reduced the pH from 9.5 to 7.38. This may be due to the chitosan causes fine sediment particles to bind together and is subsequently removed with sediment. Similar results were studied by Amudaa *et al.,* (2007) and Pan *et al.,* (1999) on coagulation/flocculation process and sludge conditioning in beverage industrial wastewater treatment. In the treated retting water, BOD and COD were significantly reduced up to 19.8 and 102.5 mg/lit respectively. Calcium, magnesium, sodium, potassium, nitrite, nitrate, manganese, sulphate, phosphate, iron and fluoride contents were reduced up to 90.3, 44.7, 310, 58, 0.12, 9.48, 0.21, 25.07, 0.55, 2.05 and 0.55 mg/lit respectively. Reduction of metals and iron in the treated water may be due to the chitosan which has the positively charged particles. It has an ability to chelate dissolved metals in water. Chelation is a process by which multiple binding sites along the polymer chain bind with the metal to removes organic molecules from retting water. Flocculants formation of chitosan actively binds with the organic molecules and other pollutants. Several municipalities in Canada have specified that chitosan is the only flocculent that can be used for storm water application. Particularly a great reduction of chloride level (624 mg/lit) was observed. This may be due to that chitosan is capable on its own or in combination with selected microorganisms to initiate and complete dehalogenation of polluted water. Most of the nutrients found in the treated retting water were reduced from above permissible limit to permissible limit.

Conclusion

The above result reveals that the chitosan may be used as an efficient eco-friendly agent to treat the coir retting effluent as it brings out reduction of nutrients, metal and also improves oxygen level. The permissible level of various nutrients and metals in the treated water may be discharged into the natural ecosystem and it may be safely used for aquaculture and crop production. It is a simple, biological and rapid effluent treating agent. The system may not be economic but also ecofriendly and sustainable.

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