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Physico-Chemical Characterization of Coir Pith Black Liquor and Coir Pith Effluent

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Abstract

Recent research focuses on the possibility of utilizing coir pith as a substrate for bioenergy production via delignification, saccharification and fermentation. Optimized hydrogen peroxide pretreatment reported as means of coir pith delignification generated coir pith black liquor (CBL). Subsequent lignin recovery from CBL generates coir pith effluent (CPE) and toxicity test had demonstrated the phytotoxic nature of CPE pointing to the need for further effluent characterization and treatment. In this work CBL and CPE were analyzed as per Bureau of Indian Standards for parameters such as pH, conductivity, colour, TDS, TSS, phenolic compounds, COD, Oil and grease, total organic content, and total inorganic content. The parameters that exceeded the permissible limits were pH (12.15), COD (5600 mg/L), TSS (200mg/L), TDS (31510 mg/L) for CBL, and COD (10080 mg/L), phenolic compounds(1.35 mg/L), TSS (114 mg/L) and TDS (42270 mg/L), in the case of CPE. COD and phenolic compounds were found to increase by two fold in case of CPE than CBL. Decolourisation and change of pH from alkaline to acidic occurred in case of CPE.

Keywords: Coir pith black liquor, coir pith effluent, cod, physico chemical characterization, decolorisation.

Introduction

Coir pith is a biomass residue which is generated during the extraction of coir fiber from coconut husk and is a byproduct of the coir manufacturing industry. Coir pith is a fluffy, light, spongy material having increased water-holding capacity[1]. It will not degrade by itself and remain in the soil for a long time. Coir pith is rich in lignin and tannin which are commercially valuable. Its accumulation on the ground during rainy seasons can pollute the soil and water through leaching of polyphenols which makes the coir pith unfit for the normal landfill practices. Therefore suitable waste management strategies have to be adopted to solve the pollution risks arising due to the lignocellulosic biomass. Recent research programs are focusing to convert waste coir pith in to useful products such as biomanure[2], biochar[3] etc. The lignino cellulosic composition of the coir pith can be explored for utilizing the substrate for bioenergy production. For this oxidative delignification of coir pith is the first step which was developed in our laboratory and reported[4,5]. The oxidative delignification of coir pith generates coir pith black liquor (CBL) and subsequent lignin recovery from it produces coir pith effluent (CPE). The CPE was found to be highly phytotoxic in previous study[6] which necessitated further characterization and treatment of the process effluents.

Due to the presence of toxic compounds coir pith black liquor and coir pith effluent are not fit enough to be discharged without proper detoxification. Prior to detoxification a comprehensive physico–chemical and biological characterization is required, which is attempted here.

Materials and Methods

Coir pith collected from coir processing unit at Alappuzha, kerala. Coir pith washed with water to remove associated soil impurities and air dried. It was used for further experiments. The effluents for the present study were generated in two steps.

Generation of Coir pith Black liquor (CBL): A quantity of 3g each coir pith was pretreated with 100ml solution of 2% H_2O_2 in Erlenmeyer flasks. pH of solutions was adjusted initially to 11.5 using NaOH and treatment was carried out for a time duration of 10 hours with slight shaking at regular intervals. Coir pith black liquor was collected as filtrate after filtration of treated coir pith in amber coloured bottles.

Generation of Coir pith Effluent (CPE): Aliquot of 80 ml of CBL was added to centrifuge tube and pH lowered to 1.7 using conc. H_2SO_4. The solution was then centrifuged at 4000 rpm for 15 min at 4°C. Lignin was obtained as residue. The filtrate Coir pith Effluent (CPE) was collected in amber coloured bottle.

Physico chemical analysis of CBL and CPE: pH measurements were made by using pH meter (Scientific Tech, model: ST2025M). The Electrical conductivity (EC) was measured by conductivity meter (Deluxe Conductivity Meter 601). Reduction in colour was determined by using spectrophotometer (Systronics Double Beam Spectrophotometer 2202) at 430 nm. Phenolic compounds in the samples were measured by using 4-aminoantipyrine method without chloroform extraction[7]. Total suspended solids[8], total dissolved solids[8], chemical oxygen demand[9], total organic content and total inorganic content[10] were determined by standard methods. Partition gravimetric method was used for the analysis of oil and grease[11].

Results and Discussion

The measured values of pH, Electrical conductivity (EC), phenolic compounds of CBL and CPE are shown in table-1.

Table-1
Table showing the physico chemical parameters (pH, EC and Phenolic compounds) of Coir pith Black Liquor (CBL) and Coir pith Effluent (CPE).

S.No	Parameters	CBL	CPE
1	pH	12.15	1.7
2	EC	30500µs	40800µs
3	Phenolic compounds	0.52 mg/L	1.35 mg/L

Bar plot showing the effect of total suspended solids (TSS), chemical oxygen demand (COD), total organic content (TORC), total inorganic content (TIRC) and total dissolved solids (TDS) values of CBL and CPE (figure-1).

Species distribution in aquatic habitat is mainly influenced by pH whose acceptable fresh water range, as per EPA is 6.5 to 9 beyond which the species diversity is significantly reduced. A change in pH can alter the chemical state of pollutants like copper and ammonia, which in turn will affect their solubility, transport or bioavailability. pH of CBL were found to be 12.15 and that of CPE 1.7. None of the process effluents studied satisfied the pH standards recommended by Bureau of Indian Standards (5.5-9)[12].

Electrical conductivity is an important indicator to show the salinity or total salt content of the effluents. Electrical conductivity of Coir pith Black Liquor (CBL) is 30500µs. But in the case of Coir pith Effluent (CPE) the value increased to 40800 µs which must be due to the presence of dissolved ions. Both the values exceeded the permissible limit as per Bureau of Indian standards (1000 µs)[12]. The higher conductivity changes the chelating properties of water bodies and produces an imbalance of free metal availability for flora and fauna[13]. It was reported that Electrical conductivity and total dissolved solids are proportional to each other[14]. In the case of CBL and CPE there is a slight difference in the values of both electrical conductivity and total dissolved solids.

TDS recorded for CBL was 31510 mg/L whereas in the case of CPE it was found to be 42270 mg/L. Both the values exceeded the Permissible limit as per Bureau of Indian Standards (2100 mg/L). It was observed that the total dissolved solids were mainly due to carbonates, bicarbonates, chlorides, sulphates, phosphates, nitrates, nitrogen, calcium, sodium, potassium and iron[15]. The large amount of dissolved solids might be due to the presence of inorganic salts and small amounts of organic matter dissolved in water[16].

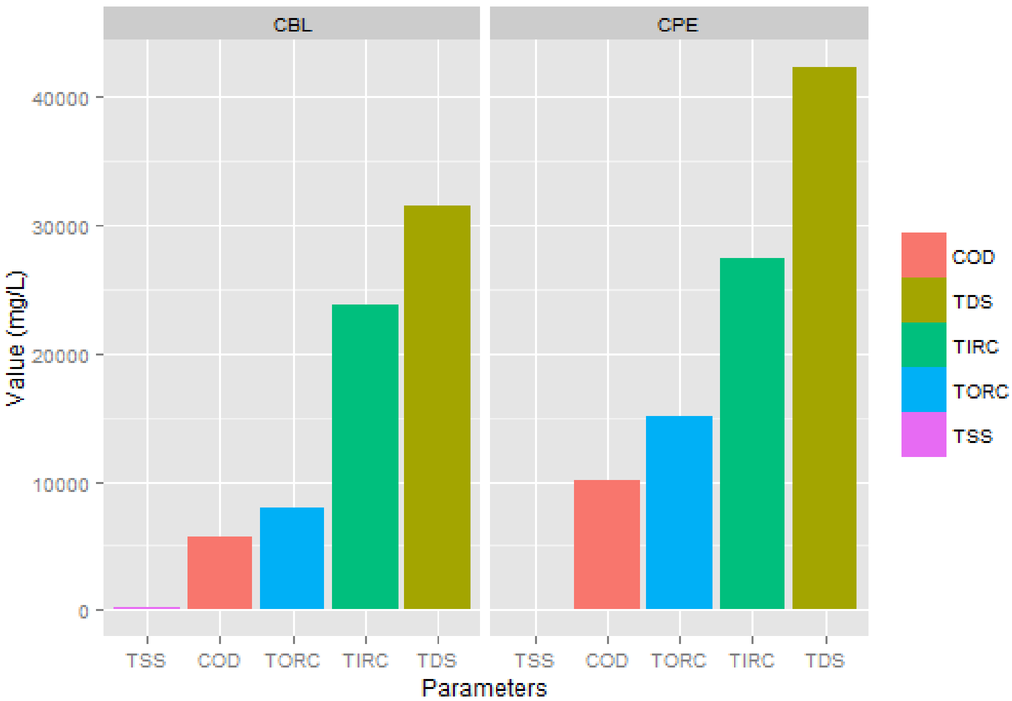

Figure-1
Bar plot showing the effect of Total Suspended Solids (TSS), Chemical Oxygen Demand (COD), Total Organic Content (TORC), Total Inorganic Content (TIRC) and Total Dissolved Solids (TDS) values of CBL and CPE

The un-dissolved matter present in water or waste water is usually referred to as suspended solids. Suspended solids reduce the photo synthesis activities of water plants by smothering benthic organism. Total Suspended Solids (TSS) value of CBL and CPE were 200 mg/L and 114 mg/L respectively which have been found to be higher than BIS prescribed limit (100 mg/L). The larger solid particulate matter remains suspended may be due to the charges on the surface of small particles in the effluent[17].

Phenolic compounds showed about two fold increase in CPE when compared to CBL. This increase might be due to the degradation of compounds present in the CBL as a result of acid addition performed during lignin recovery process.

Chemical Oxygen Demand (COD) is the amount of oxygen required to breakdown both organic and inorganic matters. It was observed that COD is used as a test to determine the degree of pollution in the effluent samples[18]. COD is useful in pinpointing toxic condition and presence of biological matters. In the present investigation, the COD value of CBL was 5600 mg/L where as in CPE it was increased up to 10080 mg/L. Both these values exceeded the permissible limit set by Bureau of Indian standards (250 mg/L). This indicated the occurrence of high organic pollutants in the effluent. A high COD level represents highly toxic nature as well as higher concentration of biologically resistant organic substances in the waste water[19].

Total organic content of CBL and CPE were found to be 7965 mg/L and 15040 mg/L respectively. Total inorganic content of CBL and CPE were 23715 mg/L and 27378 mg/L respectively. In the present investigation oil and grease was found to be below the detection level in case of both CBL and CPE.

Colour is usually the first contaminant that is recognized in waste waters which affects the aesthetics, water transparency and gas solubility in water bodies[20]. Reduction in colour from dark brown to pale yellow was observed in case of CPE. The colour was found to decrease by about 50% in CPE (absorbance 0.676) at 430 nm.

Conclusion

Physico chemical characterization of CBL and CPE indicated most of the parameters exceeding permissible limits. This suggested that further treatment methods are essential for the open disposal.

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