ABSTRACT

Development rises the economic value of a country, but alongside it leads to the degradation of the environment. Pulp and paper industries produce 220 - 380 m^3 of highly colored and potentially toxic wastewater for every ton of paper produced. The large quantities of wastewater require proper treatment prior to discharge to the environment; otherwise, it may lead to severe environmental and economic problem. One significant problem is the persistent brown color due to lignin and its derivatives. The effluents of paper and pulp industries are the major sources of water pollution, threatening the existence of aquatic biodiversity. So, their treatment or proper disposal or bioremediation before discharge is very crucial. Biofilm mediated bioremediation, is a microbial-based method, uses naturally occurring microorganisms (bacteria) to break toxic substances into less toxic or non-toxic substances. Our research work deals with the physicochemical characterization of the concerned effluent, isolation of indigenous bacterial strains, their biofilm formation ability, evaluation of their decolorizing efficiency and functional group characterization of degraded products by Fourier transform infrared spectroscopy (FTIR). Total six strains were isolated and characterized on morphological, biochemical, and genetic basis. The strains were identified up to species level using 16S rRNA gene sequencing as *B. cereus* (OP001792), *B. licheniformis* (OP001793), *K. pneumoniae* (OP001794), *P. putida* (OP001795), *B. subtilis* (OP001796), and *P. phragmitetus* (OP001797). Decolorization assay was done spectrophotometrically after regular interval of incubation period (72, 120 and 168 hours). The selected strains showed different potential for decolourization. *B. cereus* (BC-1), *B. licheniformis* (BC-2) and *K. pneumoniae* (BC-3) decolurized the BL up to 25, 23.7 and 23.6% respectively, within 72 hours of incubation period. *B. cereus* (BC-1), *B. licheniformis* (BC-2) and *K. pneumoniae* (BC-3) decolurized the BL up to 28.7, 28.4 and 36% respectively, within 120 hours of incubation period. *B. cereus* (BC-1), *B. licheniformis* (BC-2) and *K. pneumoniae* (BC-3) decolourized the BL up to 40, 45 and 53% respectively, within 168 hours of incubation period.Among the strains, *P. putida* (BC-4) had highest potential of decolourization and showed highest extent of BL decolourization. *P. putida* decolorized the BL up to 32, 44 and 65% within 72, 120 and 168 hours of incubation, respectively. *B. subtilis* (BC-5) and *P. phragmitetus* (BC-6) decolourized the BL approximately up to 2% within 72, 120 and 168 hours of incubation. *B. subtilis* (BC-5) and *P. phragmitetus* (BC-6) had significantly low potential for decolourization of BL, hence, they were excluded from further experiments. *B. cereus* (BC-1), *B. licheniformis* (BC-2), *K. pneumoniae* (BC-3) and *P. putida* (BC-4) had highest potential for decolourization of BL, hence, they were subjected to further experiments.Decolourization is inversely proportional to the concentration of effluents. Color removal percentage was decreased as the concentration of the effluents increased. At lowest concentration (10 %) of BL, highest decolourization 87, 77 and 90% by bacterial biofilm consortia C-1, C-2 and C-3, respectively was observed. Colour removal percentage was notably decreased as the concentrations of BL increased up to 100 %. Colour removal was 65, 41 and 68% by bacterial biofilm consortia C-1, C-2 and C-3 respectively, in response to 100% of BL within 168 hours of incubation period.The optimum pH range for different strains and consortia showed variations. The current study has reported optimum decolourization of black liquor at pH 7–9 using bacterial consortium (C-1, C-2 and C-3). C-1, C-2 and C-3 showed highest decolourization of BL at pH of 8, 7 and 9, respectively. At a pH of 8 (optimum pH), C-1 showed 64% BL decolourization. At a pH of 7 (optimum pH), C-2 showed 46% BL decolourization. At a pH of 9 (optimum pH), C-3 showed 70 % BL decolourization. These findings exposed the presence of indigenous dye decolourizing bacteria and signified their application in bio treatment of the black liquor.Owing to the fact that C-3 consortia showed the significant decolourization potential, FTIR analysis was used to inspect the quantitative and qualitative variations in the carbohydrate and lignin components of C-3 treated samples compared to control of paper and pulp mill effluents (PPME). Five major peaks *i.e.,* 2970 cm^{-1}, 1458 cm^{-1}, 1085 cm^{-1}, 1043 cm^{-1} and 877 cm^{-1} in untreated sample of PPME were observed in untreated samples. These peaks appeared almost flat in treated sample. This disappearance of the peaks in treated sample could be attributed to the destruction of C-H, O-H, C-O, CO-O-CO and C-Cl groups in the PPME by the bacteria consortium (C-3). Spectroscopy and FTIR analyses confirmed the decolorization and biodegradation of black liquors by the bacterial biofilm consortium. For these methods to be more effectively used it is essential to have a better understanding of the potential for biofilm-mediated bioremediation.