Abstract

Rivers representing the lifeline of the human being is now under great threats generally due to the different anthropogenic activities including large scale abstraction of river water for agriculture, wasteland reclamation, afforestation, industrial activities, fishing and aquaculture, wetland drainage operation of hydroelectric power stations etc. Bio-recalcitrant of the ores of heavy metal as major result in disruption of ecological balances and ultimately push the erstwhile pristine river into an eco-degraded landscape. Out of many rivers in India, Subarnarekha (21°33′ to 23°32′ north latitude and 85°9′ to 87°27′ east longitude) is a transboundary river which traverses through the landscapes of three states viz. Jharkhand, West Bengal and Odisha, India. This research study was initiated with the prime objective to study the ecology of benthic fungi which have the potential for bio-accumulation and bio- removal of a persistent toxic substance such as heavy metals i.e. lead (Pb-II), cadmium (Cd- II) and mercury (Hg-II). The study was aimed to record the ecological changes of the river temporarily and spatially in fungal diversity and bio-potential for removing heavy metals from three eco-contrasting astudy sites i.e. Muri (S-I), Sonakonia (S-II) and Talsari (S-III) through different months (24) and seasons (6) of two (2) consecutive years (July, 2012-June, 2014) of Subarnarekha river along with recorded hydro-biological parameters. From this study a total of 112 soil-inhabiting fungal isolates were recorded from different stretches of the Subarnarekha river basin. Out of the major soil-inhabiting fungi of the river ecosystem, the fungal species, *Aspergillus penicillioides* (F12) was found to exhibit the highest heavy metal tolerance activity. This strain of fungus was identified by the ITS genetic system and deposited into the gene bank (MN210327). It exhibited resistance against Hg (II) up to 200 ppm but Pb (II) and Cd (II) up to 1000 ppm. The heavy metal binding regions of fungus were determined by FTIR, SEM and EDEX analysis. The specific extracts from (secondary metabolites from cultured media) this species has also revealed antibacterial activities by proving their effectiveness as a potential

inhibitor against human pathogenic gram-positive bacteria, *Bacillus subtilis* and *Staphylococcus aureus* and gram-negative bacteria, *Vibrio cholerae,* and *Escherichia coli*.

The studied fungal strain *A. penicillioides* was seen to release higher quantity of exopolysaccharide (EPS), which helps absorb heavy metals in maximum amount. In view of such observation, such circumstance, it can be concluded that both EPS and biomass of fungal strain are supposed to be responsible for the bioremediation of heavy metals from the riverian flow. This study also emphasizes the optimization of processes of different physicochemical parameters [pH, time (h) and temperature (°C)] by employing Box- Behnken Design (BBD) of experiments, in order to achieve the bio-absorption capability of heavy metal [lead (Pb II)] from Subarnarekha river estuary by EPS of *Aspergillus penicillioids* (MN210327). From statistical analysis (ANOVA), the optimized bio-absorption (72.76%) of Pb (II) by EPS was obtained at pH of 11, the temperature of 37.57 °C, for a period of 8 hours. Besides, the flocculating activity was noted as the highest (88.4%) at a concentration of 0.5 mg/l EPS and the emulsifying activity of EPS was found to be about 50%. The research findings of the present study indicate that biomass and EPS of *Aspergillus penicillioides* can act as good emulsifier, flocculent and heavy metals (Pb II, Cd II, Hg II) remediator. This study also offers the possibility of the development of an alternative method for eco-sustainable bioremediation by fungal EPS which can be applied in the wastewater treatment plant. Besides, seasonability for ecological parameters for a transboundary river has been recorded with the establishment of some (sensitive and tolerant) bioindicator of fungal strain as a part of biomonitoring of the ecological changes.

Keywords: Heavy metals; Flocculation; Emulsification; Box-Behnken design; Transboundary River; Benthic fungi; Bioremediation; Bio-indicator.