National Institute of Technology Rourkela

Defence Seminar

Seminar Title	: Studies on phenol biodegradation with simultaneous lipid production by Rhodosporidium toruloides 9564T for potential biodiesel feedstock
Speaker	: Sangeeta Singh (Rollno : 519bm1008)
Supervisor	: Prof. Kasturi Dutta
Venue	: BM Seminar Hall
Date and Time	: 20 Nov 2024 (3:00 PM)
Abstract	: Waste management has become a significant concern in recent decades as a result of urbanization and the exponential growth of the global population. Industries such as paper and pulp, petroleum refining, coal processing, pharmaceuticals, and dyes discharge a wide range of hazardous organic, inorganic compounds and heavy metals. Aromatic compounds (organic compounds) and heavy metals have detrimental impacts on the environment. Prominent environmental pollutants include heavy metals (Cr, Cd, Co, Pb, Ar, Hg, Zn, and Fe), the most prevalent aromatic compounds (phenol and its derivatives, catechol, 4- nitrophenol, and 4-chlorophenol). These substances are known to be genotoxic, carcinogenic, and mutagenic. All of these contaminants are discharged into the effluent during the pulping stage of paper manufacturing, resulting in its dark colour. These pollutants possess a potent odour, are toxic and carcinogenic to aquatic and terrestrial organisms, and are classified as aqueous pollutants due to their solubility in water. The EPA designates these pollutants as priority pollutants for removal from the environment based on their toxicity. Consequently, in order to safeguard the environment and organisms, it is imperative that these contaminants be eliminated from the effluents originating from the paper and pulp sectors. Oleaginous yeast is more valuable for the remediation of these contaminants in wastewater because it produces valuable products after utilizing the wastewater. Biofuel is one of the most frequently produced by-products of oleaginous yeast. To thoroughly treat the organic debris in the wastewater effluent, the research investigation has been organized around five distinct objectives. The initial objective was to investigate phenol degradation and lipid production by using Rhodosporidium toruloides 9564^T, an oleaginous yeast. It was found that R. toruloides 9564^T completely degraded 0.75 g/L phenol with a lipid accumulation of 26.3% by following the Ortho-cleavage pathway. After completing the first objective, the second objective involved the degradation of phenol derivatives and their impact on cell morphology. The results obtained for this objective confirm that R. toruloides 9564^T possesses the ability to fully degrade catechol (upto 1 g/L), 4-CP (upto 0.5 g/L), and 4-NP (upto 0.1 g/L). The maximal lipid yield achieved during this investigation was 36% (catechol). The impact of heavy metals on phenol degradation and lipid production was investigated in objective 3. The heavy metals Zn, and Fe have been observed to improve phenol degradation by reducing the degradation period. Conversely, Cr, Cd, and Co have been found to have an adverse impact on phenol degradation and lipid production. The optimization of phenol degradation and lipid production was then investigated using the Design Expert software in objective four. Using the Placket-Burman design, an initial screening of the most significant factors (pH, temperature, agitation speed, incubation period, and inoculum size) was conducted. Four factors are chosen for optimization by RSM (CCD experiment) out of a total of five. After optimization it was observed that with optimum condition pH 6.072, temperature 29.46 °C, inoculum size 14.68% (v/v), and incubation period 92.145, the phenol was completely degraded (100%) and there was increase in lipid production of 3.35 folds (0.918 g/L). ANN-GA was implemented to validate the optimized result and data confirms that similar result was obtained in ANN-GA. A study has been conducted in the 5 L reactor subsequent to the optimization study as the final objective. A batch mode reactor study was performed to treat synthetic paper pulp industry wastewater. The results of the study confirmed that R. toruloide 9564^T exhibited phenol degradation (specifically, removal of 0.75 g/L from black liquor within 72 hours of incubation), lignin degradation at a rate of 300 mg/L, and complete adsorption of heavy metals. Based on the comprehensive findings of the study, it can be concluded that R. toruloides 9564T is among the most effective oleaginous yeasts for biodiesel production and effluent valorization.