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Study of phenol biodegradation by an indigenous mixed consortium of bacteria

Bhaswati Chakraborty[1], Lalitagauri Ray[2] & Srabanti Basu[1]*

[1]Department of Biotechnology, Heritage Institute of Technology, Kolkata 700 107, India
[2]Department of Food Technology and Biochemical Engineering, Jadavpur University, Kolkata 700 032, India
E-mail: srabanti_b@yahoo.co.uk

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The potential of a mixed consortium of bacteria has been isolated from the soil of the East Calcutta Wetlands, the major waste treatment and recovery site of Kolkata, for degradation of phenol, a representative of phenolic compounds has been investigated. The mixed culture is first acclimatized to higher phenol concentrations in the mineral salt (MS) media and then its behaviour for degradation of phenol has been studied. The mixed culture successfully degrades phenol till 200 mg/L and then undergoes substrate inhibition at 400 mg/L. At still higher phenol concentration of 800 mg/L this mixed culture shows an anomalous behaviour by degrading phenol at a higher rate as compared to lesser phenol concentration by overcoming the substrate inhibition effect. The bacterial growth curve also follows the same pattern which indicates the observation. By the kinetic modeling of the substrate inhibition biokinetic constants are calculated which conform to experimentally observed values. For the phenol degradation and growth studies, Haldane model and Yano and Koga model are found to be the most efficient kinetic models respectively.

Keywords: Bacterial consortium, Bioremediation, Kinetic modeling, Phenol.

Phenolic compounds are present in the effluents of various industries including petrochemicals, coal coking, coal gasification, tanneries etc. They are difficult to be degraded by common soil microflora and persist for a long time in nature causing environmental pollution. Operational hazards lead to leaking of gaskets, bearings etc. which could contaminate both soil and ground water with phenolic compounds[1-3]. Phenolic compounds may cause disorder of central nervous system, myocardial depression, hypothermia, renal failure, hepatitic damage, malfunction of gastrointestinal tract, loss of sight and even cancer[4].

Cleaning water from phenol producing industries may contain phenol of concentration exceeding the safety limit. Phenol was considered a representative compound of the phenolic group and the desirable limit of phenol discharge concentration set by EPA (USA) was 0.168 mg/L[5]. Therefore it is essential to reduce phenol concentrations to acceptable level in industrial effluents to maintain ecological balance. Both chemical treatment methods and biodegradation methods have been employed for this purpose. Chemical methods include adsorption, stripping, chemical oxidation and solvent extraction. Shen used modified bentonite whereas Ma *et al.* used a common adsorbent like activated charcoal for adsorption of phenol[6,7]. Other adsorbents that could be used for removal of phenol and other aromatic pollutants are activated charcoal prepared from waste rubber tyre[8], fertilizer waste[9] waste carbon slurry[10], blast furnace dust, sludge and slag of steel plants[11] etc. Gupta *et al.* have used a waste bottom ash from power plant and de-oiled soya, an agricultural waste, for chemical treatment of organic pollutants from waste water[12]. However, these methods could yield toxic intermediates. Biodegradation is considered a better method as it leads to complete mineralization of phenol[2,13-15]. Moreover, biological treatments of phenol are more economic and can handle a wide range of concentrations.

Biodegradation of phenol by aerobic, anaerobic bacteria and fungi have been reported that evolved their metabolic capacities to degrade hydrocarbons. A mixed culture has been reported to result in complete degradation of phenol with a high efficiency in degradation process and faster phenol degradation than a pure culture[16,17].

Most of the previous studies on biodegradation of phenol have used sewage water from various industries as source of microorganisms[18]. Very few works in this regard have used soil as the source of microorganisms for bioremediation. The present work has made an attempt to use soil microorganisms for