Abstract

Industrial wastewater treatment is a necessity before introducing the effluents into the ecosystem. Various kinds of chemical, fertilizer and pesticide industries are prevalent in Gujarat, India, which release a large number of hazardous pollutants in their effluents. The indigenous microflora of the industrial effluents is often not capable of treating the effluents completely and, therefore, the industries encounter difficulties to meet the stipulated norms of the regulatory authorities. Hence, development of a special microbial seed is important for the biotreatment of such industrial effluents. Methylotrophic bacteria have been studied extensively with respect to biodegradation and biotreatment, and are known to be versatile in their degradative abilities. Moreover, it has been previously reported that a mixed bacterial consortium is more effective in wastewater treatment as compared to individual microorganisms. Therefore, methylotrophs were the bacteria of choice for the development of a microbial seed for efficient treatment of diverse kinds of industrial effluents. A methylotrophic bacterial consortium comprising specially selected isolates was formulated after screening 118 bacteria isolated from various sludge and effluent samples obtained from chemical and fertilizer industries, and domestic sewage treatment plant on the basis of growth on methanol-rich fusel oil (byproduct of a fertilizer industry).

The AC consortium consisted of 4 isolates identified, on the basis of their phenotypic characters and 16S rRNA gene sequencing, as Bordetella petrii AC1, Bacillus licheniformis AC4, Salmonella subterranea AC5 and Pseudomonas stutzeri AC8, out of which Bordetella petrii AC1 and Salmonella subterranea AC5 are the methylotrophic isolates of the species first reported here. Single carbon substrate utilization, methanol utilization by gas chromatographic analysis and mxaF gene amplification confirmed the methylotrophic nature of the 4 isolates. They could tolerate high concentrations of methanol due to their high methanol dehydrogenase activity. The isolates of AC consortium showed a broad metabolic diversity which included many xenobiotics and industrially important alcohols, implying their facultative methylotrophic nature.

The AC consortium could utilize toxic xenobiotics like methyl tert-butyl ether (MTBE), tert-butyl alcohol (TBA), 1,2-dichloroethane (DCE) and 2-chloroethanol (CE) as sole sources of carbon among other xenobiotics. It showed 98 % MTBE, 94
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% TBA, 60 % DCE and 96 % CE degradation. MTBE and DCE were completely degraded by the AC consortium as no intermediates of their metabolism were detected in the GC-MS analysis. 5 l reactor studies with MTBE revealed that 100 % MTBE degradation was achieved by the AC consortium. Considering the spectrum of xenobiotic degradation of the AC consortium, it offers promising opportunities for treatment of effluents generated from various chemical industries, implying that it is a novel consortium possessing a broad range of xenobiotic degradation ability.

The AC consortium showed efficient biotreatment of 4 industrial effluents procured from fertilizer, chemical and pesticide industries and common effluent treatment plant by lowering their COD of 950 - 2000 mg/l to below detection limit in 60 - 96 h in 6 l batch reactor and 9 - 15 d in 6 l continuous reactor. The AC consortium also played an efficient role in maintaining the operating variables of wastewater treatment, viz. COD, BOD, pH, MLSS, MLVSS, SVI and F/M ratio of these effluents, in the permissible range in both batch and continuous reactors.

Therefore, formation of the AC consortium has led to the development of an efficient microbial seed capable of treating a variety of industrial effluents containing pollutants generated from their respective industries.

After analyzing the potential of the AC consortium for wastewater treatment in an activated sludge process, its biotreatment potential was studied using moving bed biofilm reactor (MBBR). The isolates of AC consortium showed a complete biofilm formation when present as a consortium. Their biofilm forming ability was enhanced by statistical media optimization using microtiter plate biofilm assay, which was subsequently used to develop the biofilm of AC consortium on commercially available Kaldnes type K1 biofilm carriers to be used for upgradation of the 6 l suspended growth reactor into MBBR. The biofilm carriers coated with the biofilm formed by the AC consortium, as observed in under scanning electron microscope, were recycled with 4 different kinds of industrial effluents. The AC consortium, immobilized in biofilm mode on the carriers, showed efficient biotreatment of the 4 effluents using MBBR by reducing their COD of 1100 - 1700 mg/l to below permissible limit which was maintained there for 120 d of the reactor run. Hence, the studies conducted concluded that the AC consortium has immense potential as a microbial seed for treatment of diverse industrial effluents with the suspended reactor process being amenable to upgradation to MBBR.