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Biodegradation of dairy effluent by using microbial isolates obtained from activated sludge

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ABSTRACT

Water resources are of significant importance to human beings. The present investigation was carried out for biodegradation of dairy effluent by using selected aerobic microbial isolates and a model having layers of sawdust and activated charcoal as filtering media. Yeast isolates (DSI_1) and two bacterial isolates (DSI_2 and DSI_3) were obtained from the dairy sludge. A mixed culture (DSI_4) was prepared by taking 1:1, DSI_1 and DSI_3 to treat the effluent and check its efficiency. After aeration period of 48 h, mixed culture of dairy sludge isolates proved to be most efficient in treatment of effluent. DSI_2 showed least reduction in chemical oxygen demand. After aeration, the reduction efficiency of DSI_4 was highest by 47.52% in biological oxygen demand in comparison with other isolates. DSI_3 was second most effective in reduction of water parameters mainly electrical conductivity, totals solids, chemical oxygen demand and biological oxygen demand.

1. Introduction

Rapid growth of industries has not only enhanced the productivity but also resulted in release of toxic substances into the environment, creating health hazards. It has seriously affected normal operations of ecosystems, flora and fauna. In recent years, considerable attention has been paid to the

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industrial wastes, which are usually discharged on land or into different water bodies. This is likely to result in the degradation of environment [1]. Various physicochemical techniques have been studied for their applicability in treatment of wastewaters [2]. These mainly include sedimentation, screening, aeration, filtration, flotation, degassification, chlorination, ozonation, neutralization, coagulation, sorption, ion exchange, etc. Several limitations of physicochemical methods including partial treatment, higher cost, generation of secondary pollutants, higher quantity solids and use of chemicals agents make the biological methods a favorable alternative for the removal of pollutants. Waste materials associated with the food industry including the wastes generated by the dairy industry namely sludge, heavy organic matter, fats, oil & grease, fatty acids, nitrogenous compounds are notables [3]. Of all industrial activities, the food sector has one of the highest consumptions of water and is one of the biggest producers of effluents per unit of production; in addition they generate a large volume of sludge in biological treatment [4]. In aerobic systems, the sludge production is about 0.5 kg per kg of removed chemical oxygen demand (COD) and in anaerobic systems about 0.1 kg per kg of removed COD [70]. Due to high pollution load of dairy wastewater, the milk-processing industries discharging untreated/partially treated wastewater cause serious environmental problems [5]. Nutrients present in dairy effluent such as nitrogen and so forth lead to eutrophication of receiving waters [6]. Dairy wastewater deserves special attention since its levels of potential contaminants typically exceed those levels considered hazardous for domestic wastewater [62]. Numerous attempts have been made to solve this problem by the activated sludge process where wastewater containing organic matter is aerated with microorganisms to metabolize the suspended and soluble organic matter. Nutrients mainly nitrogen and phosphorous from wastewaters could be reused for nutrient balance in such treatment processes. Dairy industry is found all over the world, but their manufacturing process varies tremendously [9]. This sector generates huge volume of wastewater and its pollution is primarily organic [6,10]. Dairy industry is of crucial importance to India. The country has enacted Water (prevention and control of pollution) Act, 1974 and amendments in order to treat the effluents generated by the industries and maintain wholesomeness of the natural water resources. Milk production in India has developed significantly in the past few decades from a low volume of [7,8] million tons in 1951 to 110 million tons in 2009. India's dairy sector has great potential to influence the world dairy market in long run if adequate technological progresses along with structural changes are introduced [8].

Water is a major utility in dairy industry, which results in significant effluent volumes being generated; hence the challenge of its disposal cannot be ignored. The dairy industry on an average has been reported to generate 6–10 L of wastewater per liter of the milk processed [11]. It is estimated that about 2% of the total milk processed is wasted into drains [12]. Dairy raw wastewater is characterized by high concentrations and fluctuations of organic matter and nutrient loads [61]. The composition varies depending on the operations and products [13]. The wastewater of dairy contain large quantities of milk constituents such as casein, lactose, inorganic salt, besides detergents and sanitizers used for washing [14]. The recycling of nutrients through land application of dairy waste effluent requires usage of crops capable of utilizing these nutrients [15]. Industrial effluents rich in organic matter and plant nutrients for agriculture are considered as cheaper way of disposal [16]. Dairy effluents contain dissolved sugars and proteins, fats and possibly residues of additives and are the main contributors to the organic load of these wastewaters [17]. Due to the presence of high organic load, dairy effluents degrade rapidly and deplete the DO (dissolve oxygen) level of the receiving streams and become the propagation place for mosquitoes and flies carrying malaria and other perilous disease such as dengue fever, yellow fever and chicken guinea [18]. The wastes are also characterized by strong butyric acid odor and heavy black flocculated sludge masses [19]. The dairy industries produce effluents rich in fats, oils and greases (FOGs) and can have negative impacts on wastewater treatment systems [20] as often cause foul odors, blockage of pipes and sewer lines. Volatile fatty acids (VFA) are among the most abundant volatile organic compounds in dairy manure and are associated with odor nuisance [65]. Raw milk contains of ammonia nitrogen and presence of 50 mg/L of nitrogen in wastewater stream is due to 1% loss of milk [21]. Presence of nitrate can cause methemoglobinemia if converted to nitrite [6] and contaminate groundwater. Presence of nitrogen in dairy effluent is another major problem that once converted may contaminate ground water with nitrate [22].