Chapter 7
Hydrocarbon Biodegradation Using Agro-Industrial Wastes as Co-Substrates

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ABSTRACT

The diversity of agro industrial wastes makes them an attractive group of organic wastes for potential use in a wide variety of industrial and biotechnological applications. The new stimulating development in this current area of research approaches in combination with the technologies of large-scale production and biotechnology engineering, agro industrial wastes will be economically successful materials of the future. Increased public awareness of issues related to hydrocarbon pollution strongly influences the development of technologies that speed up cleaning hazardous contaminants. The cost of biodegradation technology and the low bioavailability including mass transfer limitations of hydrocarbons, especially those recalcitrant components, from various mediums into the aqueous phase for effective enzyme-based microbial biodegradation still constitute major challenges. Sustainable replacement of traditional microbiological media with agroindustrial wastes as substrates for biosurfactant production holds great potential; thereby decrease numerous management problems of handling industrial waste. These organic nitrogen-rich nutrients (biostimulation) are an effective means to enhance the bioremediation process and widely available as wastes in the environment; hence, they can serve as "natural waste-to-environmental clean-up." However, current chapter have focused on the combined use of biosurfactants and enzymes produced from renewable resources such as agro-industrial waste, through assisted biostimulation and bioaugmentation, for hydrocarbon biodegradation.

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INTRODUCTION

Petroleum hydrocarbons are important energy resources and also a major pollutant of the environment. This in turn can cause irremediable damage to economy causing millions of losses in revenues instead to raise substantial revenues. Moreover, oil spills during exploration, transportation, and refining, have caused serious environmental problems (Zhang et al., 2011; Silva, Rufino, Luna, Santos, & Sarubbo, 2014). Hydrocarbon Oil spills is of serious concern particularly in small inland seas having very high sea traffic. In general, the most susceptible part of the world to oil spill was the Mediterranean coastal regions. This semi-enclosed Mediterranean Sea is the most active transport route for offshore oil fields connecting many continents. Expectedly, it is also the most polluted zones, with estimated annual oil dumped to be about 883,000 tons (Daffonchio et al., 2013). Although, this region constitutes only about 0.82% of the world ocean surface, it accounts for a whopping 20% of the global oil pollution (Daffonchio et al., 2013).

Environmental regulatory agencies constantly encourage companies to come up with clean and green technology. These regulations have made the oil producing companies, to develop environmental friendly strategies to detect pollution. Among all the techniques, natural cleaning method of hydrocarbons is one of the most environmental friendly routes for cleaning of oil spills. One of the most important components of natural attenuation is degraded, the change in the form of compounds carried out by living microorganisms. Under the right conditions, microorganisms can cause or assist chemical reactions that change the form of the contaminants so that little or no health risk remains (Dave & Ghaly, 2011). Hence, remedy of petroleum hydrocarbon polluted sites can be carried out by bioremediation, thereby enhance the natural process of biodegradation using biosurfactant producing and oil degrading bacterial cultures (Macaulay, 2015). Studies have shown that bioremediation is one of the most effective and best technologies available, to solve pollution of the environment due to petroleum components (Thapa, Kc, & Ghimire, 2012). Although biodegradation was revealed to be successful in naturally remediating oil contamination, much remains to be learned about the environmental controls of hydrocarbon degradation in the environment. There is a general trend to replace synthetic microbiological media with agro industrial wastes which holds great potential. Various low-cost substrates such as solid waste date (SWD), and corn steep liquor (CSL) not only act as nutrients for the microbial growth, but also act as an important source for the isolation of novel biosurfactant producing microorganisms and a higher production yield is also achieved (Gudina et al., 2015; El Mahdi, Aziz, El-Gendy, Amr, & Nassar, 2015a).

In environmental bioremediation applications, microorganisms can be supported on solid agrowaste to provide the required macro- and micro-nutrients required for biofilm formation. This usually enhances the metabolic activities of the microorganisms for solubilization and biodegradation of hydrocarbon contaminants. In the recent industrialization, the exploration of natural resources has served as a source of experimentation for scientific and advanced biotechnologies. This is giving rise to the utilizing of by products with high aggregate value in the world market, such as biosurfactants. Biosurfactants are easily degraded by microorganisms in water and soil, making these biomolecules compounds adequate for bioremediation and waste treatment (D.Santos, Rufino, Luna, J. M., A.Santos, & Sarubbo, 2016). The future success of biosurfactant knowledge of bioremediation invention is promising, but will require the specific targeting of the biosurfactant systems to reduce production costs and increase product yield (Sobrinho, Luna, Rufino, Porto, & Sarubbo, 2013). In addition extending a strong positive impact on the main global environmental problems, biosurfactant production has considerable importance to the linking of sustainable industrial processes, such as the use of renewable resources and “green” prod-