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Review: Fungal Biotreatment of Petroleum Contamination

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ABSTRACT

Interest in the biotreatment of petroleum contamination has existed since last years, in the Arabian Gulf Region of Saudi Arabia, less attention has been paid to the microbial bioremediation of petroleum contamination. In Saudi Arabia, petroleum widespread environmental and continuously pollutants that are amenable to removal by biotreatment.

The present review might give a data base in microbial biotreatment of petroleum contamination for some future studies in Saudi Arabia as well as in the Arabian Gulf region.

Most of the Eastern Regions of Saudi Arabia, including the coastal area bordering Kuwait, Bahrain and Qatar became polluted with petroleum during the Gulf War (1990), results from a 1991 rapid assessment survey to investigate the extent of resulting from the massive spillage of petroleum and the burning of oil well pollution in the Arabian Gulf was restricted to approximately 400 km from the sources, oil contamination as a floating tar balls were investigated from the Arabian Gulf to the Arabian Sea, ecology of sea grasses in North eastern Saudi Arabia after Gulf War was examined for the direct result of the Gulf War oil spill, mean concentrations of total hydrocarbons were 2.95,4.14 and 3.29 ugl-1 in Saudi Arabia and Qatar respectively , petroleum contamination following the 1991 Gulf War was organized to determine contamination by petroleum that entered the Gulf and oil field in Kuwait .

While environmental biotechnology benefits is broadly based in variety of environmental protection, restoration ,and agriculture industrial practices, for a decade it has been most commonly liked with bioremediation , rehabilitation and waste treatment technology.

1) INTRODUCTION

Microorganisms can degrade petroleum as a carbon and energy source and this might provide scope to remediate petroleum contaminated sites [1, 2, 3, 4].

There are several problems dealing with petroleum contaminated soil which effect human health and environmental quality, the present review may give some opportunities in bioremediation of petroleum contamination for some future studies in Saudi Arabia as well as in the Arabian Gulf Region.

A unique microbial cocktail with promising potential for remediating oil polluted desert in Saudi Arabia belonging to different genera of bacteria as well as fungi belonging to different genera been isolated from petroleum contaminated site [5, 6, 7, 8].

Cyanobateria colonized southern Saudi Arabia Region after the second Gulf war in 1991 because of the largest oil spill, followed the extensive formation of cyanobaterial mats [9].

A laboratory degradation study of the oil spilled during the 1991 Gulf War has given pattern, the study suggested the presence of naturally occurring microorganisms are very effectively in rapidly biodegrading several PAH compounds [10, 11].

The application of microorganisms activities dominates present day biotechnology , the primary importance of microorganisms in human affairs makes it desirable that know as much as possible about their ecology , physiology and genetics , to realize the full biotechnological potential of these microorganisms .Biotechnology of petroleum prospecting through methanogenic bacteria is a wide method for petroleum prospecting now a day , many theories have been advanced to explain the origin of petroleum and associated natural gas .

Bioremediation of petroleum contaminated soils us a treatment

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technology that utilize naturally occurring soil microorganisms to degrade petroleum hydrocarbons to carbon dioxide and humus [12].

Most of the Eastern Region of Saudi Arabia including coastal area become polluted with petroleum during the 1991 Gulf War , fungal species could degrade petroleum and use it as a carbon and energy source were isolated from petroleum contaminated soil such as *Alternaria aletrnata*, *Alternaria chlamydosporium*, *Aspergillus carbonarium*, *Aspergillus flavus*, *Aspergillus funiculous*, *Aspergillus niger*, *Aspergillus thomi*, *Aspergillus zonatus*, *Chaethomium piluliferum*, *Cladosporium herbarum*, *Cladosporium resinae*, *Eurobium* sp., *Fusarium solani*, *pencillium chrysogenum*, *Penicillium expansum*, *Penicillium notatum*, *Trichoderma* sp., *Ulocladium chlamydosporium* [5, 6, 13].

Fungal species isolated from contaminated petroleum soil such as *Alternaria altrnata*, *Aspergillus flavus*, *Curvularia lunata*, *Fusarium solani*, *Mucor racemosum*, *Penicillium notatum* and *Ulocladium atrum* [14]. *Aspergillus flavus* isolated from petroleum contaminated soil from Saudi Arabia can grow and utilize different gasoline concentrations in mineral medium amended with different concentrations of gasoline [5].There is a big problem concerning petroleum contamination in the Arabian Gulf Region, the basic concept of bioremediation has been recognized and which used for many decades and it is one of the most promising technology on the horizon for petroleum contamination in Saudi Arabia [11, 15].

The potential advantage of applying bioremediation principles to clean up of oil contaminated sites have been recognized for some time, the benefits include reduced cost , because bioremediation can be much cheaper than other technologies, reduced risk of exposure by avoiding the need for excavation, minimal environmental impact, bioremediation also a natural process that has the potential of degradation toxics to harmless products such as carbon dioxide and water , and reduce residual contamination [16]. *Aspergillus flavus*, *Curvularia lunata* and *Fusarium solani* isolated from contaminated soil from Saudi Arabia were able to degrade crude oil and use it as a source of energy and carbon, to which the crude oil contain a wide range of organic compounds that are nutrients for microorganisms such as the tested fungi [17].

Different scientific identification for petroleum contamination removal has been used such as bioremediation, biodegradation, bioteratment, biostimulation, biosoprption and bioaugmentation [18, 19, 20].

Bioaugmentation defined as the inoculation of contaminated site with special isolated microorganisms to cleanup hazardous contaminants such as crude oil, while bioremediation is introducing selected microbial population which known to be efficient into a contaminated site [21, 22].

Several conditions must be satisfied for bioaugmentation, such as microorganisms must have a necessary enzyme for bioaugmentation, and must present in the contaminated sites,the pollutants must be accessible to the microorganisms with the requisite enzymes and the conditions must be conductive to allow for proliferation of the potentially active microorganisms [22].

Bioaugmentation for oil spill is a much more promising technique especially in Saudi Arabia [23]. *Alternaria tenius*, *Aspergillus romosus* and *Ulocladium atrum* [24] can grow in all different concentrations of crude oil, *A. ramosus* able to grow and degrade crude oil more than the other selected tested fungi especially at higher crude oil concentration, colony growth rate evaluation has been used to investigate the growth of filamentous fungi for hydrocarbon degradation [1] it also observed that the tested fungi shift pH toward acidity [16, 17].

Hydrocarbons microorganisms are ubiquitous in nature but are found at relatively higher densities in petroleum contaminated soil [25], microbial removal of hydrocarbons is also a natural process that has the potential of degrading toxic substance to harmless products such as carbon dioxide and water also reduce residual contamination [26, 27, 28]. *Aspergillus nidulans*, *Rhizopus arrhizus* and *Trichoderma reseum* can grow at different concentrations of crude oil [17].

A diesel degrading fungus was isolated from a diesel contaminated site in Riyadh city, Saudi Arabia [29] and tentatively identified as *Ulocladium atrum*, study using different concentrations of diesel in mineral liquid medium showed that the fungus can grow in all diesel concentrations (Figures 1, 2 and Table 3).

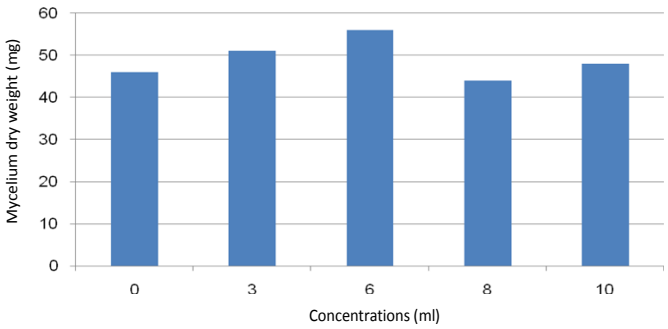


Figure 1. Mycelial growth rate of the tested fungus at different concentrations of diesel after 21 days of growth.

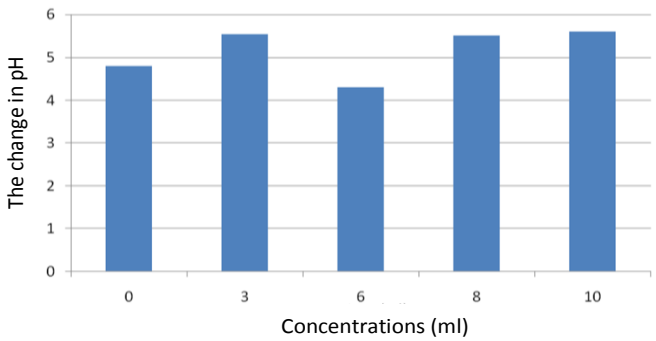


Figure 2. The changes in pH of the filtered medium after 21 days of *U. atrum* growth at different concentrations of diesel (ml).

Several conditions must be satisfied for biodegradation to take place in an environment, these include the following:-

a- microorganisms must exist which have the necessary enzymes to bring about biodegradation.
b – Microorganisms must be present in an environment containing the pollutants.
c – The pollutants must be accessible to microorganisms having the requisite enzymes.
d – Conditions in the environment must be conductive to allow for proliferation of the potentially active microorganisms [30].
The characteristics of all tested fungi isolated from Saudi Arabia in this general review are suitable for bioremediation of petroleum and its products contamination , nevertheless , because microbial successes are clearly evident because the hydrocarbonic molecules are destroyed , the most important role of the tested microorganisms in the transformation of pollutants such as petroleum or diesel are their abilities to bring about detoxification , which refers to the change in a molecules that renders it less harmful to one or more susceptible species , detoxification results in inactivation , with the toxicology active substances being converted to an active products [31, 32].
The petroleum and its products contaminated soil also tested to which soil was dried at 80 ^{o}C overnight and allowed to be adsorbed for 30 min ,after adsorption of crude oil , the humidity was adjusted to approximately 45% , the soil had an organic matter content of 5.8% , nitrogen content of 0.23% and an available phosphate content of 25%,control soil samples and sterilized and non-sterilized soil samples were included, seven grams of soil with adsorbed crude oil or diesel were placed in a flask and inoculated with any of the tested microorganism (bacteria or fungi which isolated from Saudi Arabian contaminated hydrocarbons soil),and incubated at 37^{o}C,the control was carried out without addition of the tested fungi (n=5) and the sampling was programmed once a week for seven weeks for crude oil or diesel disappear.

2) CONCLUSION AND RECOMENDATIONS

In Saudi Arabia , Crude oil responsible for the generation of large amounts of organic residues, as well as for pollution of air , soil and water , so one of the best approaches to restoring contaminated environments is to make use of the physiological potential microorganisms to degrade the pollutants in bioremediation process , an attractive approaches have been used in different studies to cleanup hydrocarbons pollutants because it is simple to maintain ,applicable over large areas , cost effective and leads to the complete destruction of the contamination .
The results of this general review indicate that the isolated microorganisms from petroleum contaminated soil can grow in the contaminated sites and can transfer the crude oil and it is products to their cells as a source of carbon and energy, and this is my help the contamination removal in the Gulf Region, to get out of the problems of petroleum contamination were the Gulf Region and Saudi Arabia are considered to be one of the main crude oil expert in the world.

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Table 3. Mycelial growth rate of the tested fungus at different concentrations of diesel (ml).

Harvest days	Diesel concentrations (ml)									
	0		3		6		8		10	
	W	pH	W	pH	W	pH	W	pH	W	pH
7 Days	30±0.3	4.8	33±0.15	5.11	48±0.3	5.6	53±0.6	5.1	50±0.11	5.11
14 Days	35±0.11	4.5	48±0.3	5.8	51±0.6	5.1	42±0.11	5.8	53±0.03	4.8
21 Days	46±0.6	4.8	51±0.5	5.53	56±0.3	4.3	44±0.9	5.5	48±0.5	5.6

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