Short Communication

Microbial biotreatment of petroleum contaminated soil

A. R. H. Binsadiq

College of Science, King Saud University, P. O. Box 2455, Riyadh 11451, Saudi Arabia. E-mail: binsadiq@ksu.edu.sa.

Accepted 23 October, 2013

A crude oil degrading fungi were isolated from a contaminated area from Eastern region of Saudi Arabia and tentatively identified as Aspergillus nidulans, Rhizopus arrhizus and Trichoderma resueme. This research was done using different concentrations of crude oil in mineral liquid media. The results showed that these fungi are able to grow in all crude oil concentrations. The characteristics of this study suggest that the tested fungi are suitable for biotreatment of crude oil contaminated soil.

Key words: Crude oil, biotreatment, soil, contamination, fungi, Saudi Arabia.

INTRODUCTION

Interests in the treatment of crude oil spillage on soil and the use of microorganisms as biotreatment methods of crude oil have existed for many years (Davies and Westlake, 1979; Grasset and Vogal, 1995; Colombo et al., 1996; Mentzer and Ebere, 1996). Early studies showed that the widespread hydrocarbon oxidizing bacteria were limited by N and P when crude oil was introduced to soil, and the formulations containing oleophilic fertilizers were particularly beneficial.

Crude oil microorganisms, use for treatment, are ubiquitous in nature but are found at relatively higher densities in petroleum contaminated soil; among those isolated are bacteria and fungi (Aitken et al., 2004; Omokaro and Putheti, 2009; Joshi and Pandeus, 2012; Binsadiq, 2012).

The potential advantage of applying biotreatment principles to clean up petroleum contaminated soil have been recognized for some time, the benefits include reduced cost (in that biotreatment can be much cheaper than other technologies), and reduced risk of exposure by avoiding the need for excavation (it has minimal environmental impact).

Biotreatment is also a natural process that has the potential of degrading toxic substance to harmless products such as carbon dioxide and water, and reduce residual contamination (Oliver and Magot, 2005; White et al., 2006; Obire et al., 2008).

In Saudi Arabia, petroleum widespread environmental pollutants are amenable to removal by biotreatment.

MATERIALS AND METHODS

Aspergillus nidulans, Rhizopus arrhizus and Trichoderma resueme were isolated from all contaminated soil from Eastern region, Saudi Arabia, using dilution plate method. The tested fungi were grown on PDA plates, discs of mycelium were cut from the margin of relatively growing colonies using a 4 mm diameter sterile cork borer, and were then transferred to 250 ml conical flask (1 disc/flask) containing 100 ml mineral liquid medium as basal medium (K$_2$HPO$_4$, KH$_2$PO$_4$, NH$_4$Cl, MgCl$_2$, CaCl$_2$/g/l), the medium was adjusted to pH 6 before being sterilized by filtration through Millipore filter. After that Crude oil was added to the flasks at 0, 3.6 and 10 ml, and incubated at 36°C, harvest were taken at 10, 20 and 30 days. At harvest, mycelia were transferred to preweighed filter paper, washed thoroughly with dionized water, and were then oven dried at 80°C for 24 h and weighed, the pH's of the residual media were also measured.

RESULTS AND DISCUSSION

The mycelial dry weights at 10 ml concentration of crude oil of the tested fungi after 30 days of growth are given in Table 1. The tested fungi were able to grow at different rates.

It is clear from this study that the tested fungi were capable of growth and were able to utilize the crude oil and hydrocarbon products, which can act as a suitable
Table 1. Mycelium dry weight of the tested fungi (mg) at 10 ml concentration of crude oil after 30 days of growth with the change in the pH of the residual media (n=5±, standard deviation, start pH=6).

<table>
<thead>
<tr>
<th>Tested fungi</th>
<th>Mycelium dry weight (mg)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. nidulans</td>
<td>88 ± 0.96</td>
<td>4.11</td>
</tr>
<tr>
<td>R. arrhizus</td>
<td>155 ± 1.31</td>
<td>4.13</td>
</tr>
<tr>
<td>T. reeseum</td>
<td>75 ± 0.89</td>
<td>3.80</td>
</tr>
</tbody>
</table>

media for microbial growth and also act as source of carbon and energy (Mohanen et al., 2005). Microflora, however, responds to microbial growth by the addition of soil petroleum products and causes the added substrate to disappear from the community (Mindara et al., 2007).

The results obtained from the tested fungi can be used to draw a biotreatment protocol involving the optimization of parameters, such as bioaugmentation and bioremediation for the recuperation of areas contaminated by crude oil and different petroleum products.

The tested fungi also have been frequently reported as a degrader of various petroleum products (Binsadiq and Al-Obaid, 1999; Santos et al., 2007; Nwaogu et al., 2008).

As shown in Table 1, it is obvious that R. arrihzus was able to degrade the crude oil more than the other tested fungi, and also able to grow at higher concentration of crude oil.

Crude oil contains a wide range of organic compounds that are nutrients for microorganisms such as the tested fungi in this study. Moreover, fungal mycelia can penetrate crude oil, thereby increasing the surface area available for biotreatment, and also can grow under environmental stresses conditions such as low pH and poor nutrient status. It is clear from Table 1 that there is a shift toward acidity in the residual media. The biotreatment of crude oil in an acid soil is pH = 4.5.

In Saudi Arabia, less attention has been paid towards microbial biotreatment of crude oil. The present study might be used as a data base in microbial biotreatment of crude oil contamination for more future study (Binsadiq, 2013).

Conclusively, based on this study’s results, the tested fungi possess biotreatment potential for the purpose of removing crude oil contamination. Therefore, colony growth rate analysis was a satisfactory tool to evaluate the potential of the tested fungi in the degradation of crude oil. Beside, nearly all successful bioremediation involve the use of this techniques described earlier on the actions of endogenous microorganisms (Raina et al., 2000; Readman and Lee, 2002; Dos Santos et al., 2007; Binsadiq, 2013).

REFERENCES
