Bioremediation of Crude Oil Contamination Soil with Livestock Waste

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Abstract
A research on bioremediation of crude oil contaminated soils with poultry droppings, cow dung and combination of both wastes was carried out in the laboratory of soil/crop department of Rivers State University Port Harcourt. Total Heterotrophic count was taken for 150 days and the result shows that contaminated loamy sand had $3.0x10^7$ cfu/g and contaminated clay soil had 2.2x10+, also contaminated loamy soil, cow dung and poultry dropping had $3.0x10^7$, contaminated clay soil, cow dung and poultry dropping had $2.0x10^7$, contaminated clay and cow dung had $2.0x10^7$ and finally contaminated loamy and poultry dropping had $3.2x10^7$ while contaminated clay and poultry dropping had 2.1x107. The research shows that bioremediation of crude oil is enhanced more in loamy sandy soil than clay soil using organic fertilizers such as cow dung and poultry droppings.

Key Word: *Bioremediation, crude oil, contaminated soil, livestock waste.*

Introduction

Global increase in the use of petroleum and its products has led to severe contamination of soil and ground water. Indeed, the negative effects of pollutants in the environment and on human health are diverse and depend on the nature of the pollution. The estimated cost for the cleanup of contaminated sites with conventional techniques like incineration and landfill have been reported to be enormous and insufficient (Dixon, 1996). In United States for instance, it was estimated that restoration of all contaminated sites will cost approximately $17 trillion (Kuiper et al., 2004). Furthermore, incineration can result in air pollution, leaches from Landfills can reach ground water and drinking water wells (Kuiper etal., 2004), whereas excavation of soil can lead to the generation of toxic air emissions (Okecha, 2000 and Kuiper et a!., 2004).

Large number and size of areas in most developed and developing countries like Nigeria are contaminated with crude oil (hydrocarbon pollutants and heavy metals). introduction of these pollutants into the environment may be naturally occurring (natural oil seeps) or anthropogenic as in the case of accidental or deliberate spills and leakages such as intentional or accidental bursting of pipelines (Okpokwasili and Amanchukwu, 1988; Leahy and Colwell, 1990; Young andCemig1ia, 1995; Mentzer and Ebere, 1996; Anderson, 1996; Okecha, 2000; SVMS, 2001 and NPC, 2004 a and b). In Nigeria, the terrestrial and aquatic environment of the oil rich Niger Delta region and its adjourning areas are the main recipients of crude oil spills. It most times lead to enormous pollution of their ecosystem (Ifeadi and Nwankwo, 1989; Olagbinde et al, 1999; SVMS, 2001 and NNPC, 2004 A and, B) resulting in loss of microbial communities, habitat of economically important fish species and other aquatic animals, damage to wet lands along the coast as well as areas of vegetation meant for agricultural purposes etc. These however, pose serious threat to public health (Nwachukwu and Ugorji, 1 995; Mishra et al., 2001; bed et al., 2002 and Page et al., 2002).

Consequently, there is need for innovation methods to restore these polluted sites especially in an inexpensive, environmentally friendly manner. And among the many unique methods employed to clean up heavy metals and oil polluted sites, biomediation (in-situ) — a process that involves action of microorganisms to other biological systems, is the most widely used (Caplan, 3; YOL and Cerniglia, 1995; Sayler et a!., 1997; .Horsfall and Spiff, 1998; macnaughton et cii., 1998; Mishra et a!., 2001; Ijah and Antai, 2003; Dua et 2002 and Koren et al., 2003. Bioremediation is the exploitation of microorganisms degrades or detoxifies organic contaminant. Bioremediation as a technology attempts to optimize the natural microbial capacity to degrade petroleum hydrocarbon by providing proper conditions for the microbial population, including essential nutrients Bioremediation of organic waste is becoming an increasingly important method of waste treatment (Atlas, 1981). Bioremediation enhances the disappearance rate of crude oil hydrocarbons in the field (Venosa et al., 1.999). The advantages of this option include inexpensive equipment, environmentally friendly nature of the process and simplicity (Nadeau et a!., 1993). However, one disadvantage of this process is its relative s1ow speed in achieving results (Odokuma and Dickson, 2003). According to Lee et a!., (1993), bioaugmentation and biostimulation are methods of bioremediation geared towards enhancing and speeding the process. Bioaugrnentation involves the addition of external microbial populations (indigenous or exogenous) to the waste. Sometimes they are genetically engineered (Okpokwasili et a!., 1986). Biostirnulation involves the addition of appropriate microbial nutrients to a waste stream. These may either occur in-situ or ex-situ (Lee and Levy, 1987, 1989, 1991). The objective of this process is to stimulate the indigenous microbial flora of the waste to bring about its degradation (Odokuma and Dickson, 2003).

One of the main challenges associated with biostirnulation (that is, nutrient enrichment to enhance bioremediation on) in oil-contaminated coastal areas or tidally influenced fresh water-rivers and streams, is maintaining optimal nutrient concentrations in contact with the oil (Venosa et al., 1999).
The public has responded favourably to biostimulation as an operational oil spill counter measure, as its implicit goal is that of reducing toxic effects by converting organic molecules to benign cell biomass and “environmentally friendly” products such as carbon dioxide and water (Lee et al., 1999).

Justification of the Study

This work will try to establish if wastes from livestock farms can be used in bioaugrnentation and biostirnulation processes involved in the bioremediation of oil spill sites. The research will try to encourage the use of cheap organic manures that are locally available and more environmentally friendly, in the treatment of soil affected by oil spill. If established, the result will aid a faster approach in the recovery of oil polluted farm lands for agricultural activities.

Objectives of the Study

1. To determine the efficacy of Bioremediation of crude oil polluted soil with cow dung and poultry dropping.

2. To evaluate the effectiveness of Bioremediation with a combination of cow dung and poultry droppings.

Materials and Methods
Sample Collection and Treatment
Soil samples (Loamy sand and clay) were collected from an agricultural area with no history of oil spillage. These two types of soil were found in Ogonil and, oil producing areas of Niger Delta of Nigeria. The soil samples were collected at depths f 0-15cm. processing of the soil samples started immediately upon arrival at the laboratory. Physiochemical properties of both types of soil were determined prior to crude oil contamination. Analysis and classification of soil types was carried out according to Atuanya (1991). Crude oil obtained from Eleme refinery, Port 1-larcourt, was used in the experiment. Both types of soil samples was contaminated with the crude oil at the loading of 6.00/kg (75m1/kg).
The soluble mixture of cow dung alone, poultry drops alone, and cow dung and poultry drop together, were used oil separated soil samples respectively. These enrichment processes was used to carry out the experiment at a temperature of 28°C on a Shaker (150rpm) using a phosphate buffered, p1-I-neutral salt medium with crude oil as the major carbon source.

Bioremediation Experiments
Plastic pans (20cm x 20cm x 10cm deep) were used as experimental units. For each of soil, four pans were prepared. In each pan, 1.0kg of soil was weighed and the soil was contaminated and mixed with 6000mg of crude oil. The water content was adjusted with sterile distilled water to 60% of the maximum water holding capacity. Water losses during incubation were compensated for by regular addition of sterile water. For each soil type, pan contained crude oil contaminated soil. The set-up on pan 1 above was examined for the effects of indigenous soil microorganisms. The second pan for both soil types were added 400mg of 200mg each of cow dung, and poultry droppings. The third pan for both soil types were added 400mg each of cow dung. The fourth pan for both soil types was added 400mg each of poultry droppings. The content of the pans was mixed thoroughly every second day to achieve sufficient aeration. The pans were covered with perforated plastic sheets and incubated at room temperature (28°C) for 150 days (Atuanya and Ibeh, 2004).
Immediately after starting the experiment and at intervals of 15-30 days, soil pH, total heterotrophic bacteria and crude oil degrading bacteria were determined according to methods described below. All the determination was carried out in triplicate.

Statiscal Analyses
The results for microbiological analysis were subjected to graphing data and standard error of means analyses according to Millar (2001).

Result and Discussion
Microbiological Analysis
Total Heterotrophic Count
The result of total Heterotrophic Bacteria count on different bioremediation which was taken at 30 days and for 150 days. The total Heterotrophic bacteria count for contaminated loamy soil is 3.0×10^{7} cfu/g of soil samples after 150 days and contaminated clay soil is 2.2×10^{7} cfu as shown on the fig below.

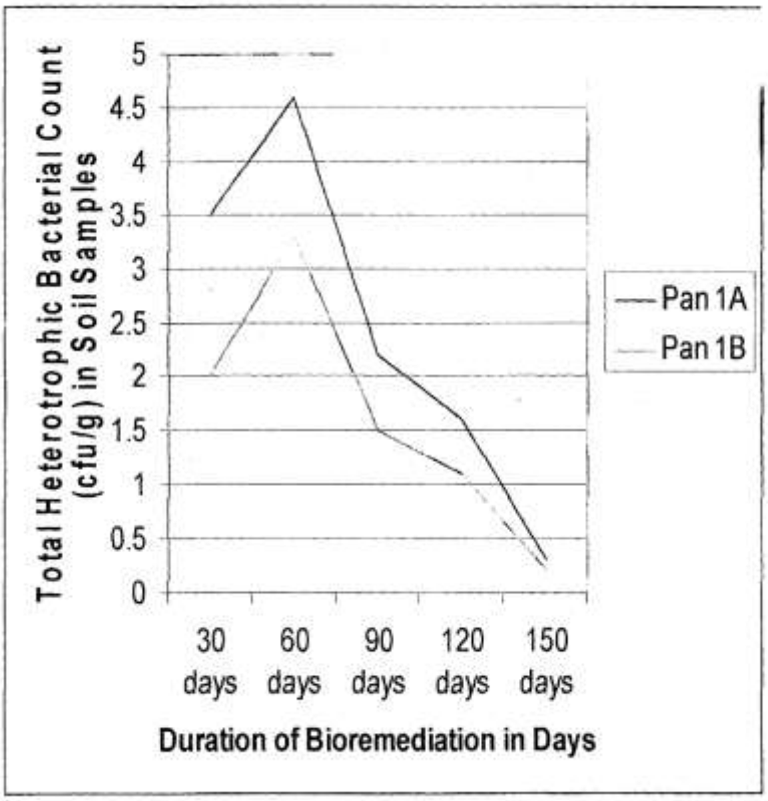

Fig. 1: Total Heterotrophic Bacterial Count (THBC)

The total heterotrophic bacterial count for contaminated loamy soil, cow dung and poultry droppings is 3.0x 10^7 cfu/g of soil samples and that of contaminated clay soil, cow dung and poultry dropping is 2.0x10^7 cfu/g. the result shows greater growth in contaminated loamy soil, cow dung that of and poultry dropping as shown on the fig 2 below.

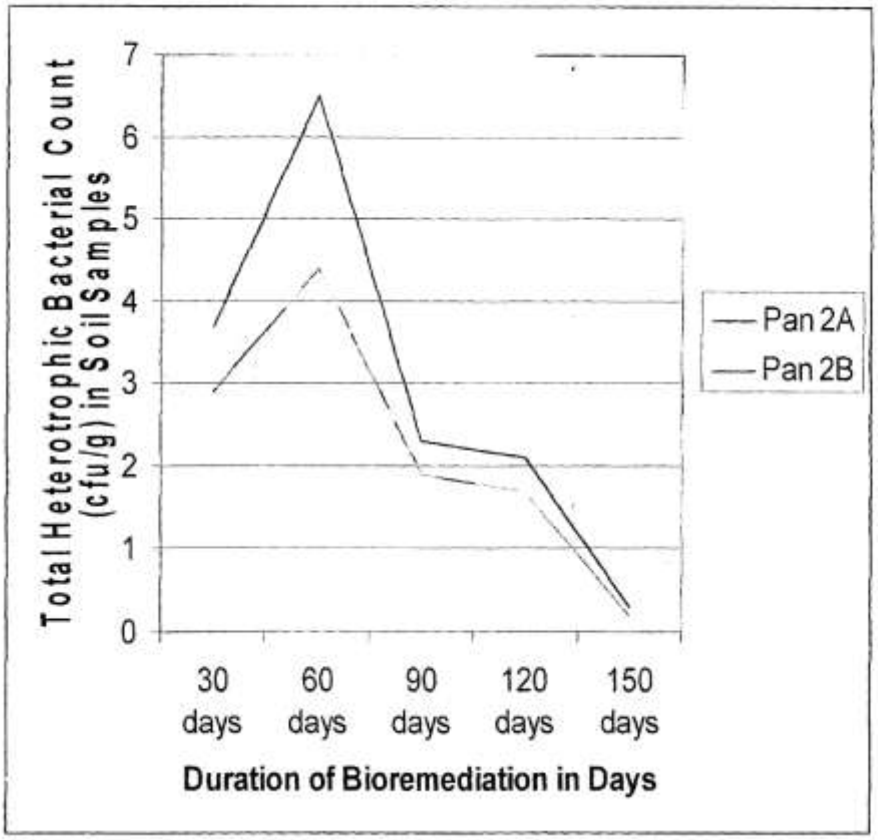

Fig. 2.0: Total Heterotrophic Bacterial Count (TIIBC)

That of contaminated loamy soil and cow dung is $3.0x10^7$ cfu/g and that of contaminated clay soil and cow dung is $2.0x10^7$ cfu/g it also observed that total hetero bacterial count was greater in contaminated loamy soil with cow dung as shown on the fig below.

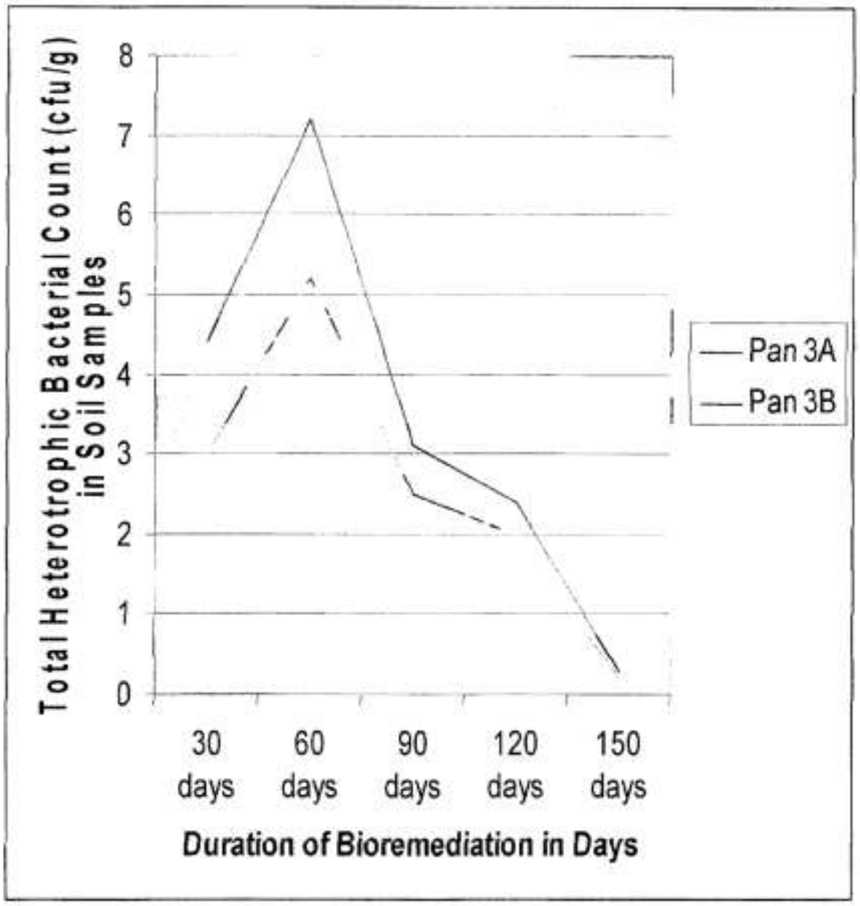

Fig. 3.0: Total Iieterotropiiic Bacterial Count (THEC)

Also the total heterotrophic bacterial count for contaminated loamy and poultry dropping is 3.2x10^7cfu/g and that of contaminated clay and poultry dropping is 2.1x10^7 cfu/g.

It was also observed that there were high bacteria counts in loamy – said soil than in clay soil as shown on the fig below.

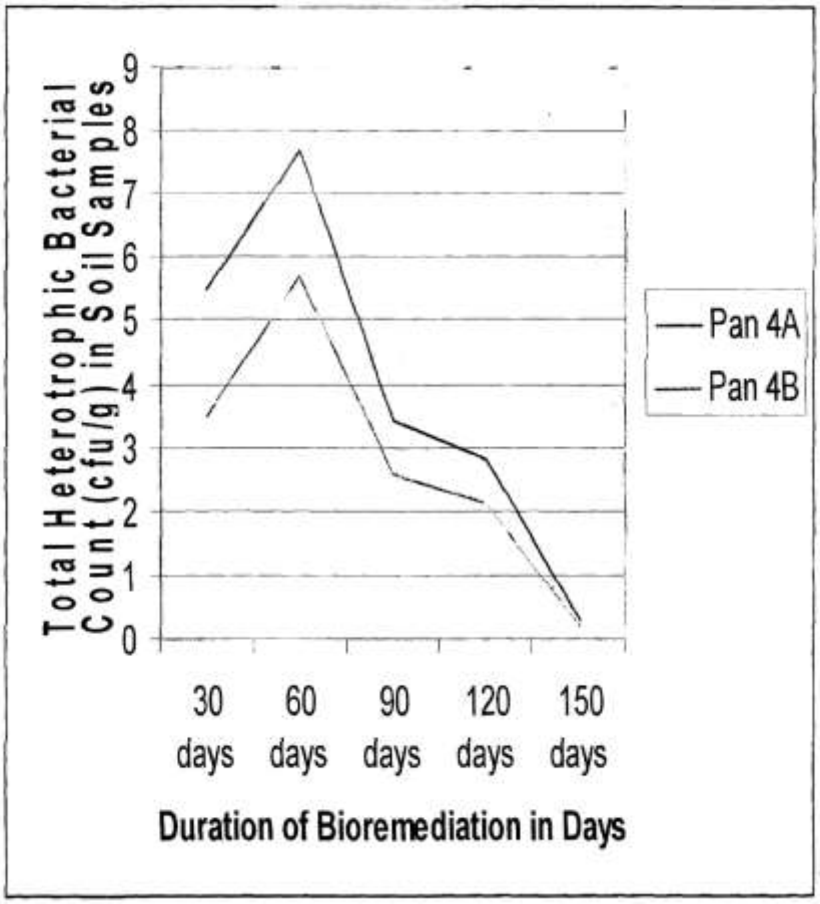

Fig. 4.0: Total Ileterotrophic Bacterial Count (THBC)

Crude Oil Degrading Bacterial Count

The result of crude oil degrading bacterial count on different bioremediation conditions for contaminated loamy said between 30 days and 150 days was $2.0x10^5$ cfu/g and for contaminated clay soil, it was $1.4x10^5$ cfu/g. The result shows higher count of CODBC in contaminated loamy sand soil than contaminated clay soil as shown on the fig below.

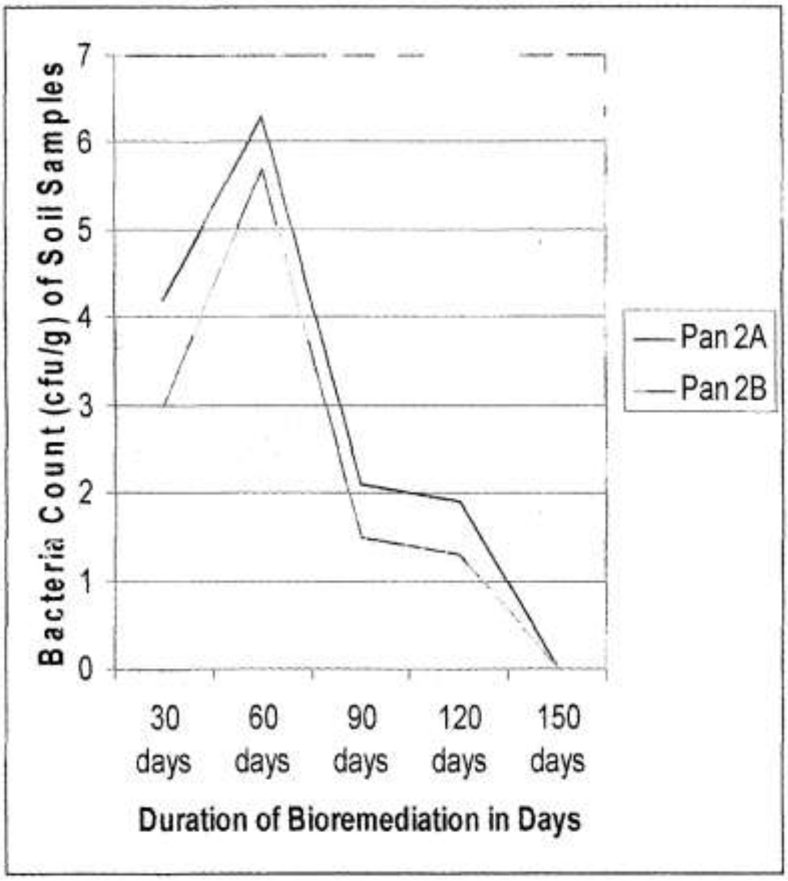

Fig. 5: Crude Oil Degrading Bacterial Count (CODBC)

It was also observed that contaminated loamy soil cow dung and poultry dropping had a higher $2.0x10^5$ while contaminated clay soil cow dung and poultry dropping is $1.8x10^5$ cfu/g. this shows that loamy soil, cow dung and poultry dropping had a higher CODBC than contaminated clay soil, cow dung and poultry dropping as shown on the fig below.

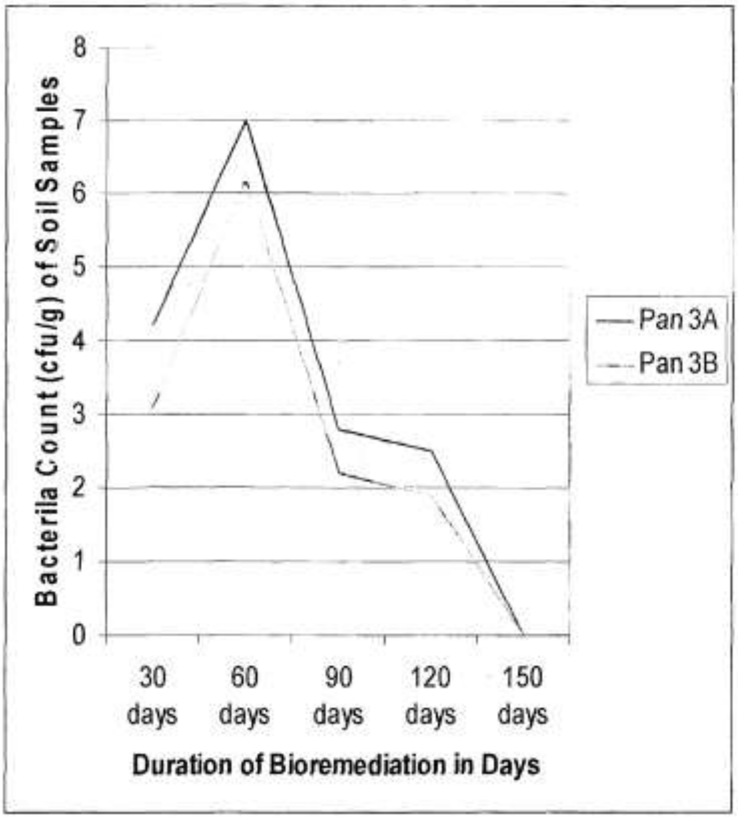

Fig. 6.0: Crude Oil Degrading Bacterial Count (CODBC)

Also contaminated loamy soil and cow dung had $3.2x10^5$ cfu/g while contaminated clay soil and cow dung had $2.5x10^5$ cfu/g. This shows that contaminated loamy soil and cow dung had a higher crude oil degrading Bacterial count than clay soil and cow dung as shown on fig. below.

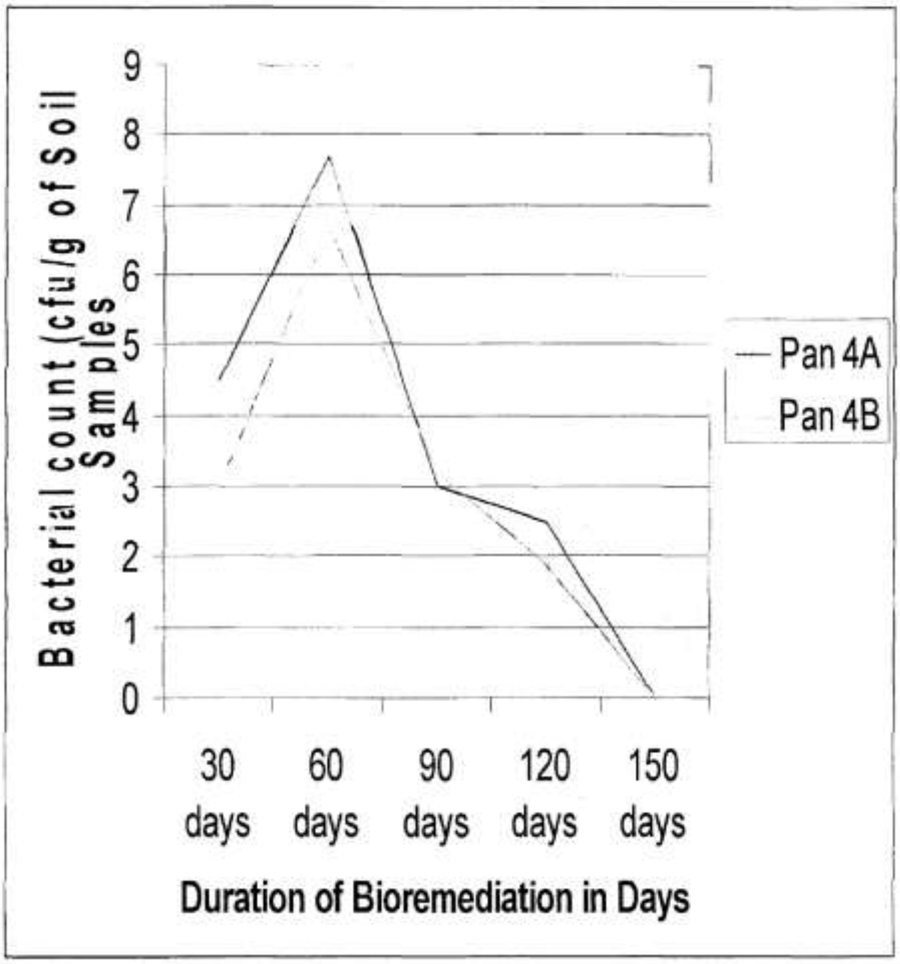

Fig. 7.0: Crude Oil Degrading Bacterial Count (CODBC)

Conclusion/Recommendation

Bioremediation of crude oil contaminated soils with organic fertilizers like poultry droppings and cow dung is a step in the right direction in the management of crude oil polluted soil.

These organic fertilizers are affordable, available and environmental friendly materials.

As a result of this, it provides easier community partnership in the management of oil spillage and this will reduce dependence of communities on oil companies and government on the restoration of contaminated soils and thus increasing Agricultural production which will enhance economic status of the farmers.

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