Effect of Bioremediation Using Livestock Waste on Physiochemical Properties of Crude Oil Polluted Soil in Ogoni Land, Nigeria

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Abstract
An examination of biodegradation of crude oil contaminated soils with poultry droppings, cow dung and combination of both livestock wastes was carried out in the laboratory for physiochemical analysis. The pH was slightly acidic in contaminated loamy –sand and alkaline in contaminated clay soil and stabilized to neutrality later. Carbon dioxide clay soils ranged between 223 – 107mg and 107 – 62mg, mineral hydrocarbon in contaminated loamy sand and clay soils reduced to 8.2 – 6.6% and 11.1 – 8%. The experiment showed that bioremediation of crude oil is enhanced more in loamy sand than in clay soil by biostimulation using environmentally sustainable organic fertilizers.

Key words: *Bioremediation, Crude Oil, Physiochemical Properties Livestock Waste.*

Introduction

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; Mentzer and Ebere, 1996; Okecha, 2000; and SVMS, 2001). 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. In most times lead to enormous pollution of their ecosystem (SVMS, 2001) 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, 1995).

Consequently, there is need for innovation methods to restore these polluted sites specially in an inexpensive, environmental friendly manner. And among the many unique employed to clean up heavy metals and oil polluted sites, biomediation (in-situ) — a process that involves action of microorganisms or other biological systems, (Atlas, 1981) is the most widely used. Bioremediation is the exploitation of microorganisms degrade or detoxify organic contaminant. Bioremediation as a technology attempts to optimize the natural microbial capacity to degrade petroleum (Horsfell, *et al*., 1998) 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. Bioremediation enhances the disappearance rate of crude oil hydrocarbons in the field. The advantages of this option include inexpensive equipment, environmentally friendly nature of the process and simplicity. However, one disadvantage of this process is its relative slow speed in achieving results. 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. Biostimulation involves the addition of appropriate microbial nutrients to a waste stream. These may either occur in-situ or ex-situ. The objective of this process is to stimulate the indigenous microbial flora of the waste to bring about its degradation.

One of the main challenges associated with biostimulation (that is, nutrient enrichment to enhance bioremediation) in oil-contaminated coastal areas or tidally influenced fresh water-rivers and streams, is maintaining optimal nutrient concentrations in contact with the oil (Caplan 1993).

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.

Objective of the study

The objective of this paper was to report the effect of bioremediation using livestock waste on physiochemical properties of crude oil polluted soil in Ogoni land, Nigeria.

Justification

This research aims at establishing if wastes from livestock farms can be used in bio augmentation and biostimulation processes in involved in bioremediation of oil spill sites.

Materials and Methods

Soil samples (Loamy sand and clay) were collected from an agricultural area with no history of oil spillage.

These two types of soil were collected in Ogoni land oil producing areas of Niger Delta in Nigeria. The soil samples were collected at the depth of 0 – 15cm. physiochemical properties of the soil were determined priority to crude oil contamination. Crude oil from Eleme Refinery Port Harcourt were used in the experiment in contaminating the soil samples collected.

Bioremediation Experiments

Plastic pans (20cm x 20cm x 10cm deep) were used as experimental units, for each of the 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 set-up on pans above was examined for the effects of soil pH, carbon dioxide evolution and mineral hydrocarbon content for indigenous soil. The second pan for both soil 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 were added 400mg each of poultry droppings.

The pans were covered with perforated plastic sheets and incubated at room temperature (28^0C) for 150 days (Atuanya and Ibeh, 2004), soil pH, Carbon content and mineral hydrocarbon were taken.

Statistical Analysis
The results were analysed using graphing and standard error of means Millar (2001).

Result and Discussion

Soil pH analysis

The result on soil pH of all loamy –sand soil samples were slightly acidic while that of clay soil were alkaline at 30days. After 30days, 60 – 150 days, the pH remained within neutrality for all samples as shown below.

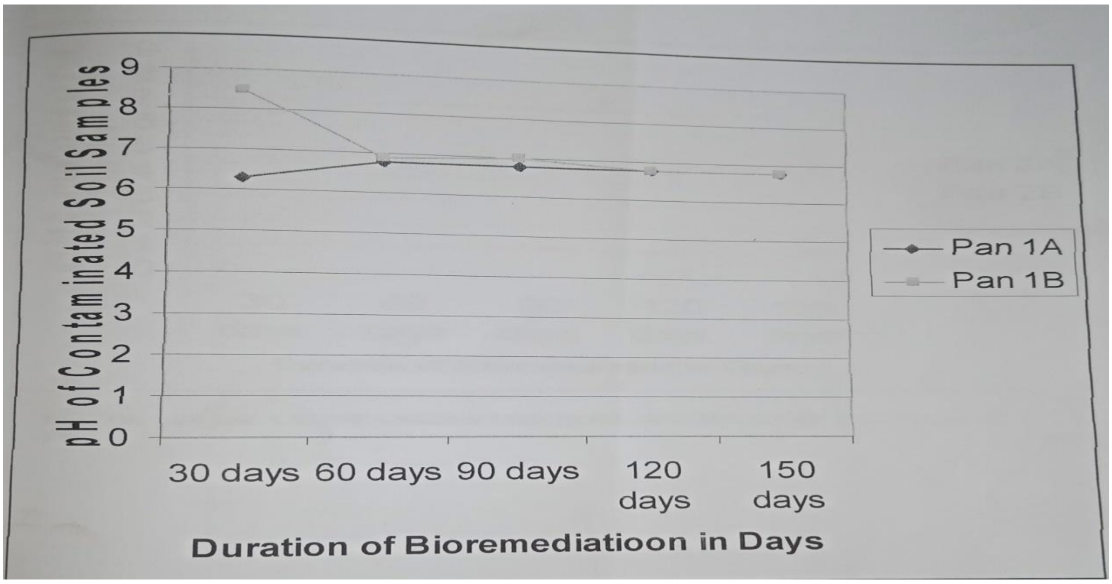

Figure 1: pH of contaminated soil samples in Pan 1A and 1B

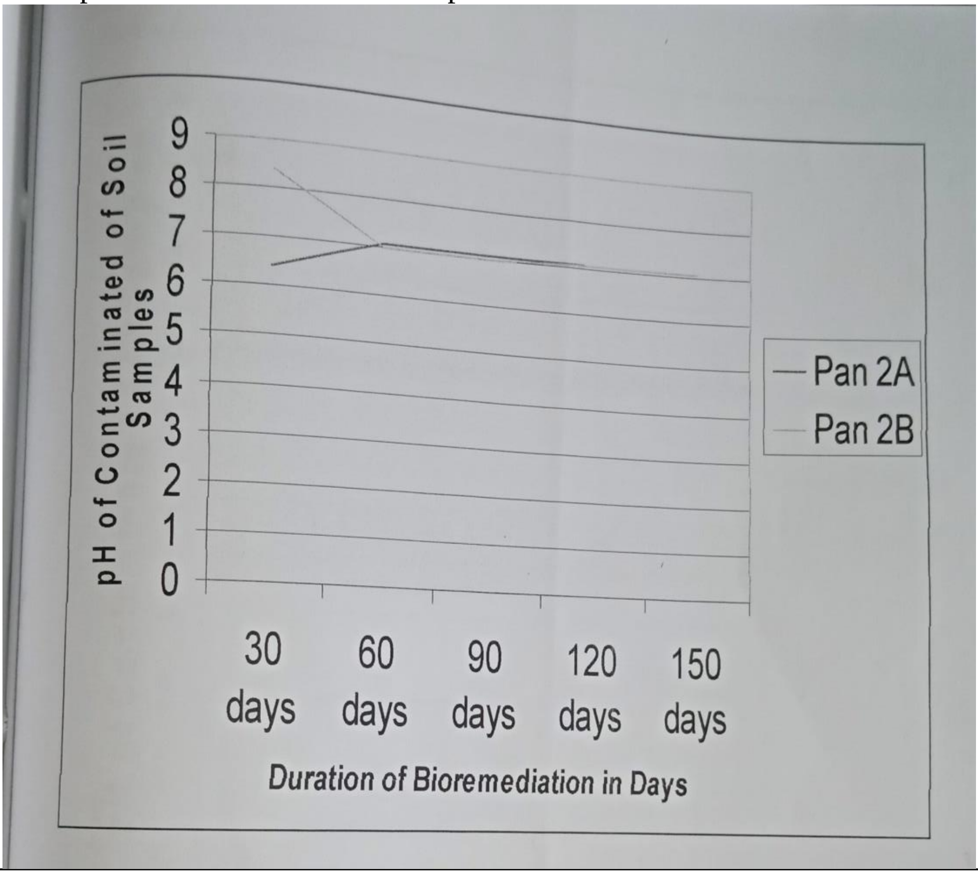

Figure 2: pH of contaminated soil samples in Pan 2A and 2B

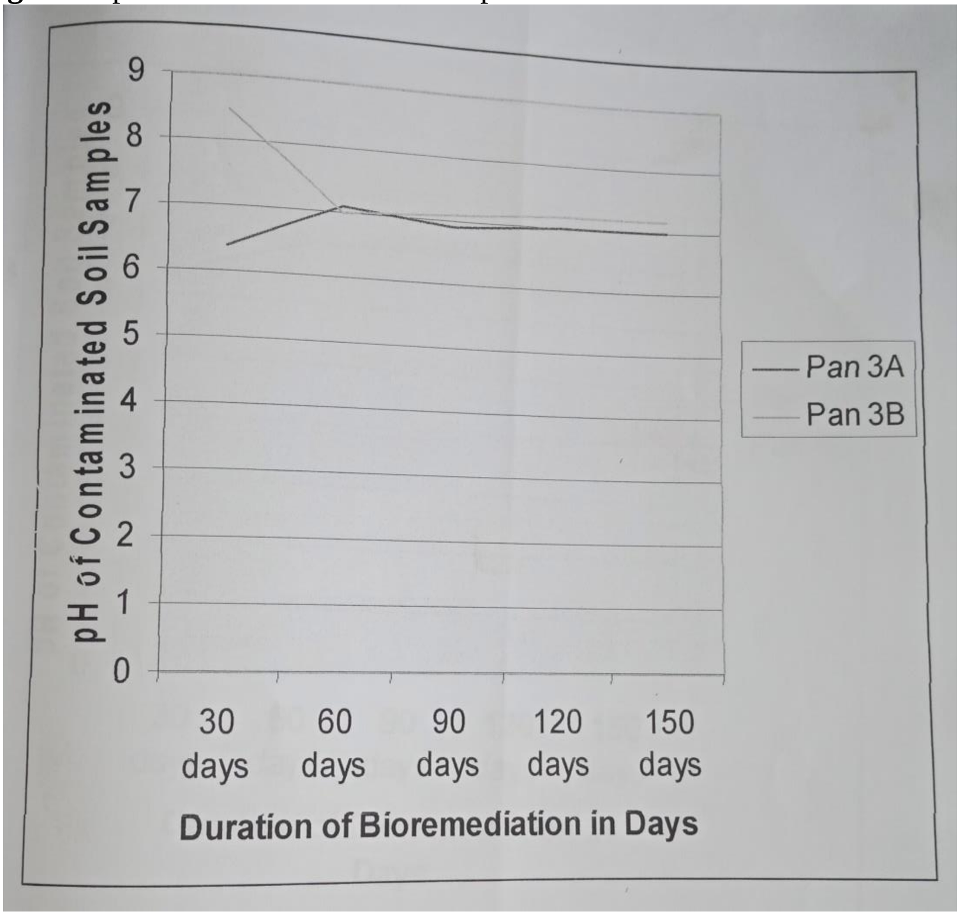

Figure 3: pH of contaminated soil samples in Pan 3A and 3B

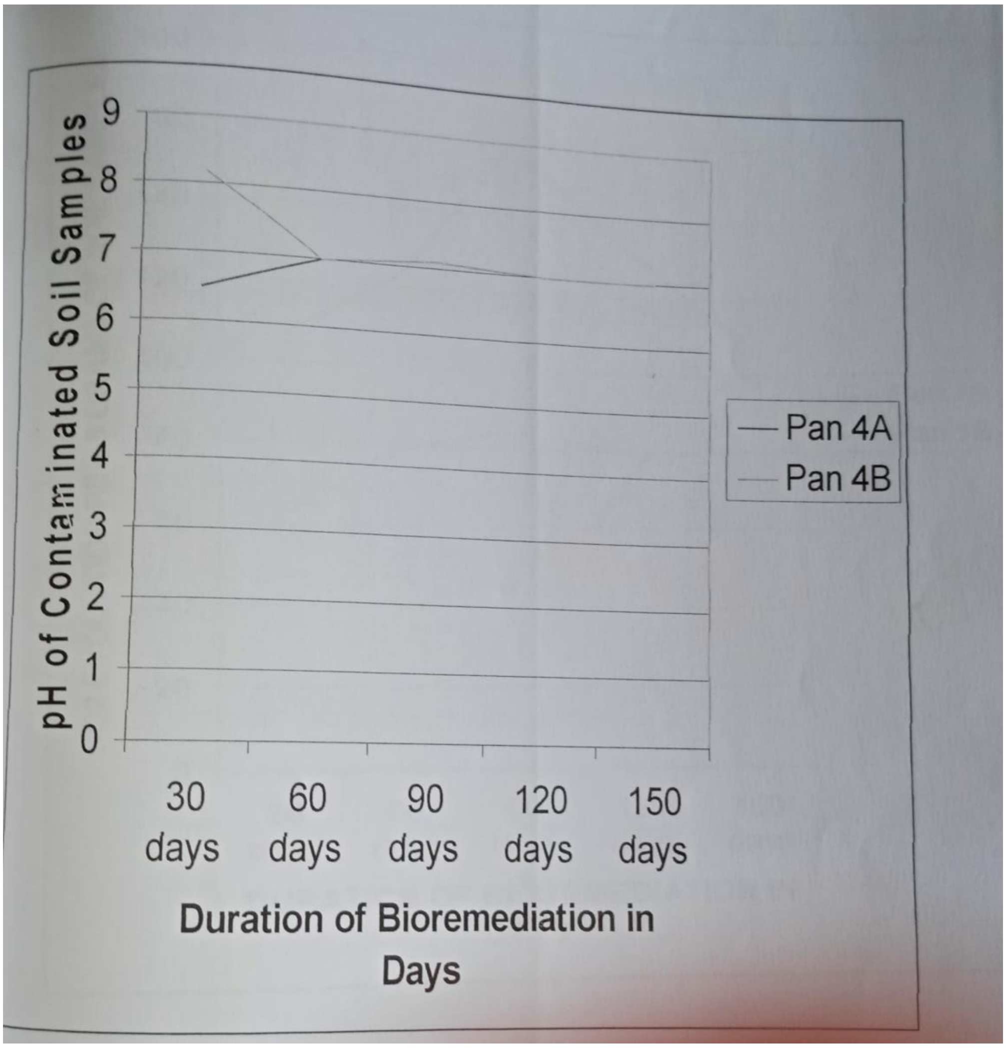

Figure 4: pH of contaminated soil samples in Pan 4A and 4B

Carbon Dioxide

The carbon dioxide result for pan 1A ranged from 107 – 158mg while pan 1B ranged from 62 – 85mg, pan 2A ranged from 123 – 180mg while pan 2B ranged from 74 -89mg, pan 3A ranged from 167 – 197mg while pan 3B ranged from 78 – 107mg pan 4A ranged from 195 – 223mg while pan 4B ranged from 83 – 100mg more CO_2 was involved in loamy contaminated soils than in clay soil as show on the fig below,

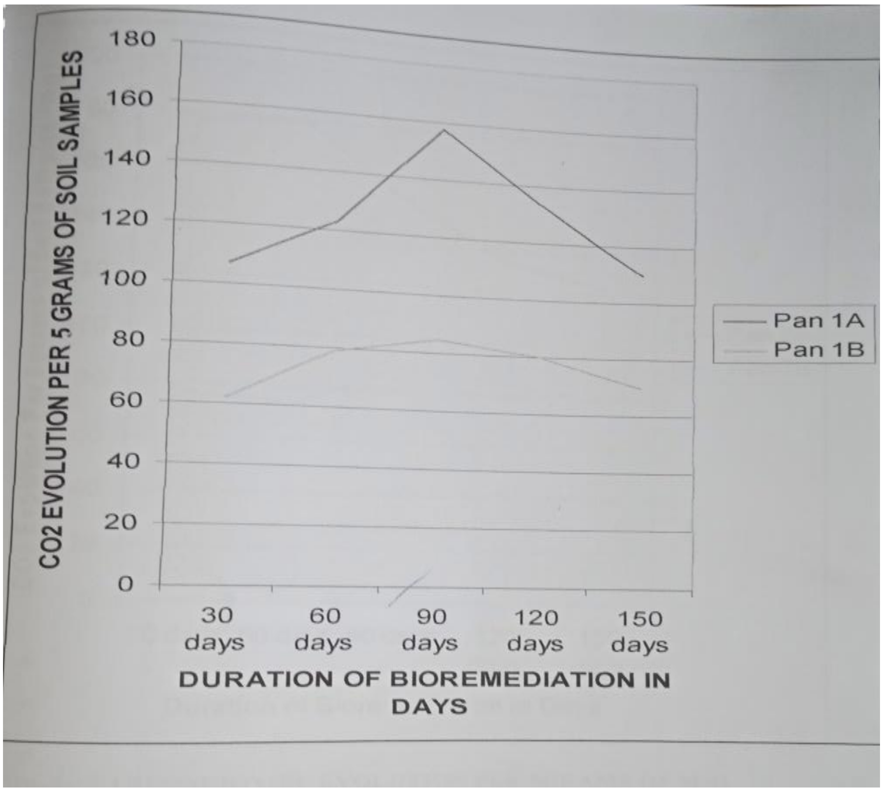

Figure 5: Carbondioxide evolution per 5grams of soil samples in Pan 1A and Pan 1B

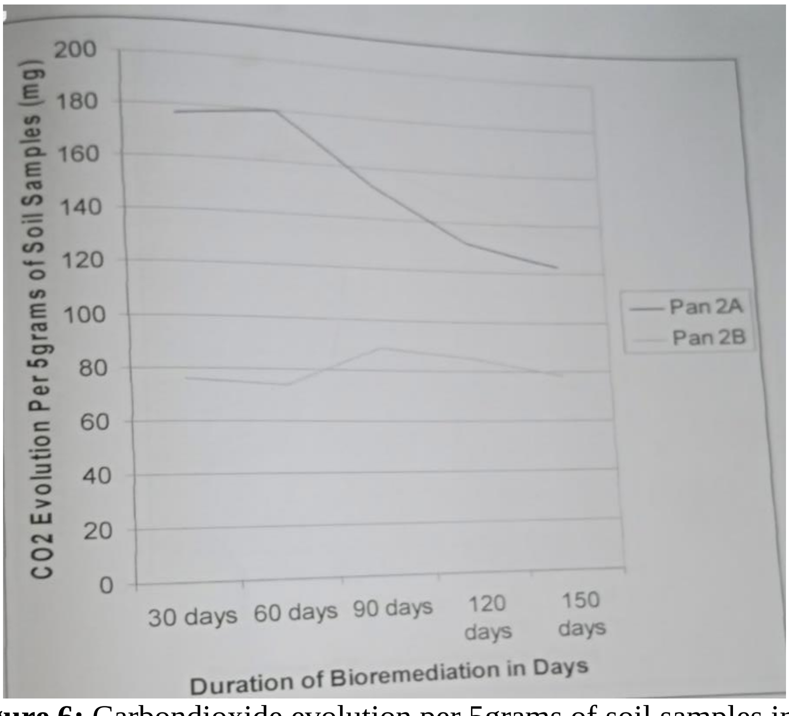

Figure 6: Carbondioxide evolution per 5grams of soil samples in Pan 2A and Pan 2B

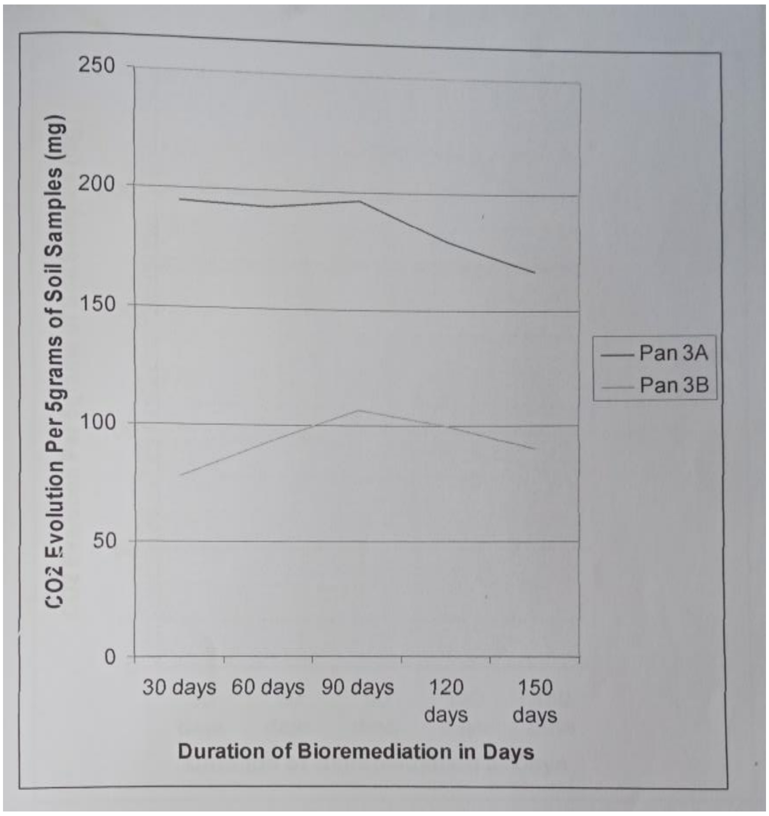

Figure 7: Carbondioxide evolution per 5grams of soil samples in Pan 3A and Pan 3B

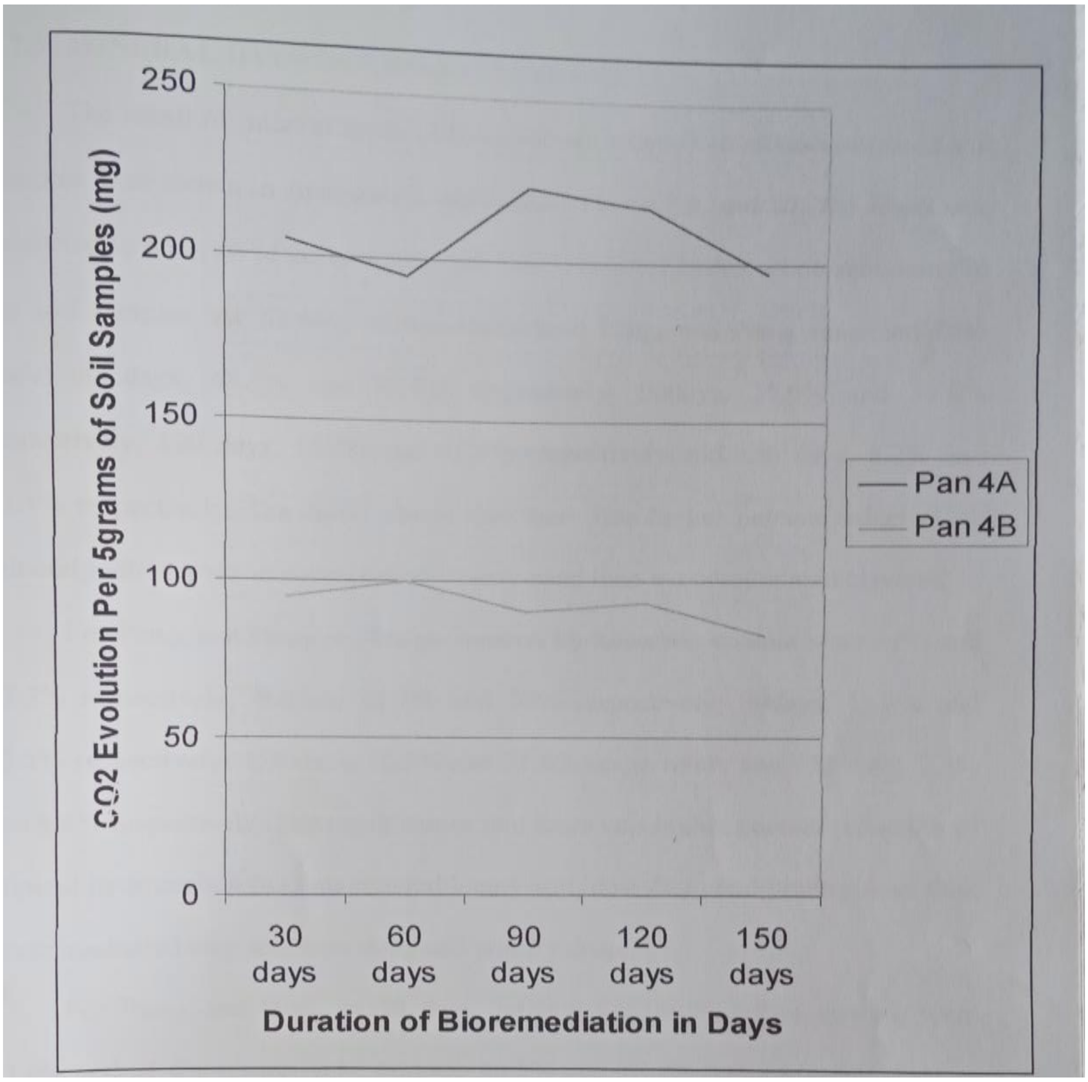

Figure 8: Carbondioxide evolution per 5grams of soil samples in Pan 4A and Pan 4B

Mineral Hydrocarbon Content

The result of mineral hydro carbon content analysis shows that at 30 days pan 1A and pan 1B remained 76% each, 60days – 48.2% and 52.8%, 90days – 30.6% and 33.8% 120 days – 11.2% and 12.5% and 150 days 7.3% and 8.6%.

Pan 2A and 2B at 30days mineral hydrocarbon content were 63.6% and 51.4%, 60days 46.7% and 45.7% 90days 10% and 11,4%. And pan 4A and 4B at 30days, mineral hydrocarbon content were 49.5% and 53.75, 60days 40.8% and 43.4%, 90days, 13.7% and 15.2%, 120days – 6.6% and 8%. Generally, irrespective of the pan the results, shows that there was higher percent reduction of mineral hydrocarbon in contaminated loamy sand and poultry dropping than in contaminated Clay soil and poultry dropping.

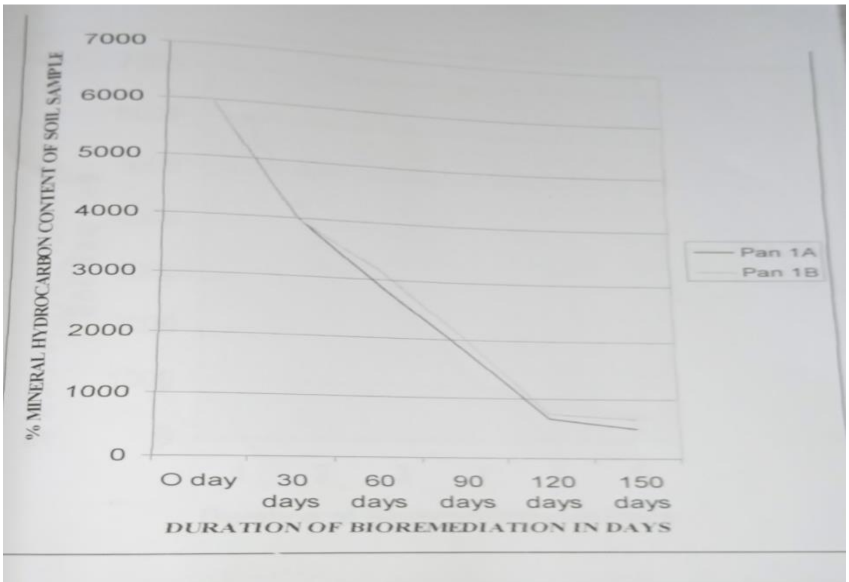

Figure 9: Percentage mineral hydrocarbon degradation in Pan 1A and 1B

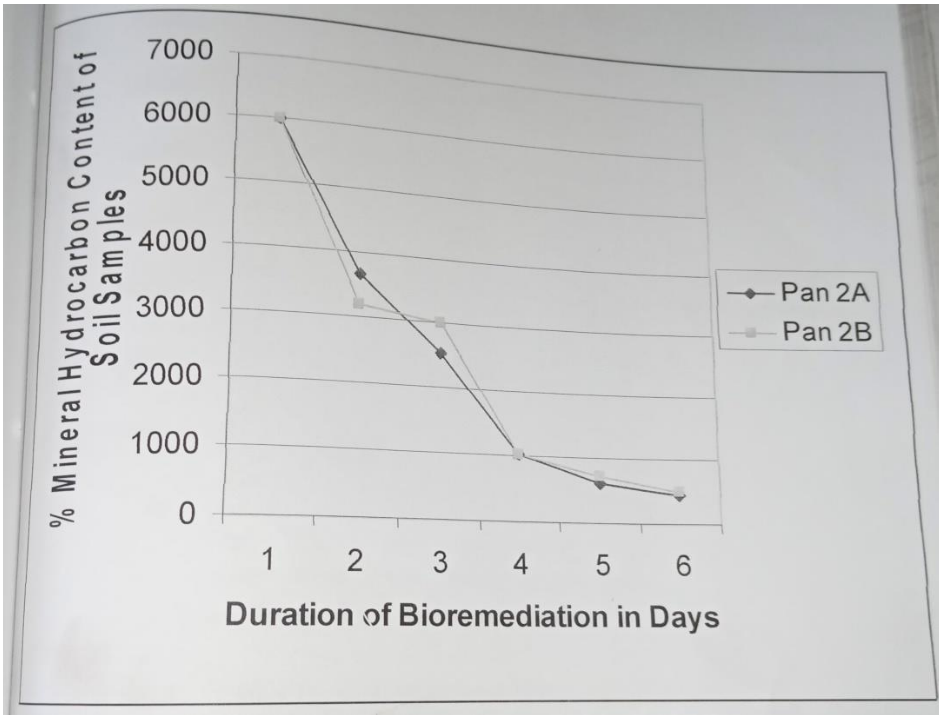

Figure 10: Percentage mineral hydrocarbon degradation in Pan 2A and 2B

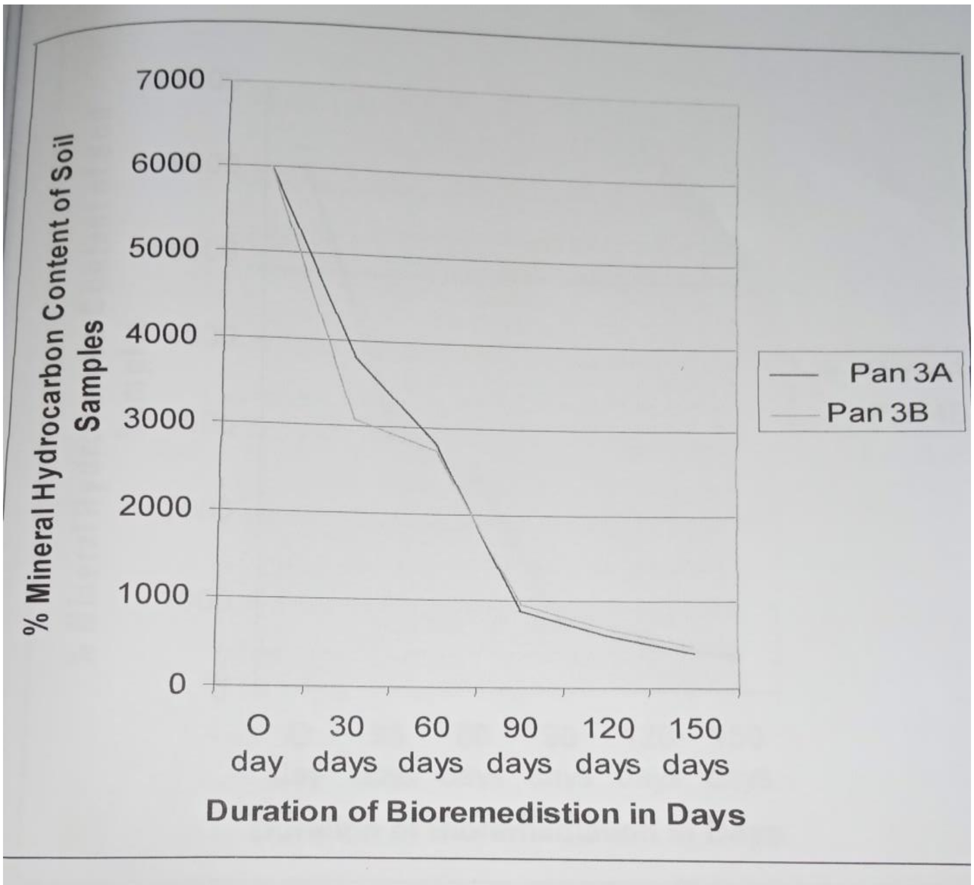

Figure 11: Percentage mineral hydrocarbon degradation in Pan 3A and 3B

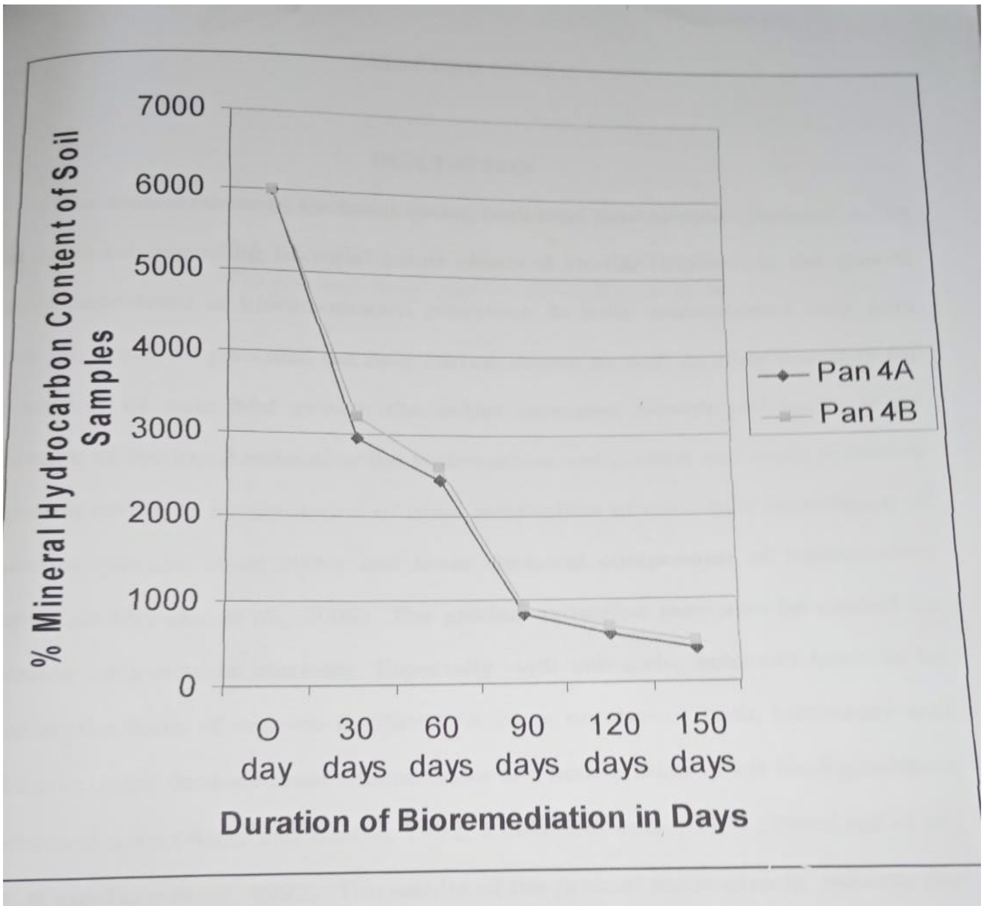

Figure 12: Percentage mineral hydrocarbon degradation in Pan 4A and 4B

Conclusion and Recommendation

Bioremediation of crude oil contaminated soils with organic fertilizers like poultry droppings and cow dung is effective in management of oil polluted soil and these organic materials needed are available and affordable by the, affected communities.

Application of these organic manures will enhance agricultural production.

It is recommended that poultry droppings and cow dung can be used as organic manure in bioremediation of crude oil polluted soil.

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