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Research Article

Effect of Oil Spillage on Soil Bacteriological and Physicochemical Properties in Awoye Community, Ilaje, Ondo State, Nigeria

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Abstract: A total of nine soil samples were collected at the depths of 0-10, 10-20 cm and 20-30cm respectively from oil polluted soils of Awoye and Osustech farm (Control). The soil samples were analyzed for physico-chemical and bacteriological properties that reflect soil nutrient content and fertility status in the laboratory using standard methods. The results of microbial flora in areas with and without oil spill shows little effect on the microbial populations of the soils studied. The average microbial population of the oil polluted soil was 9.9 x 10^3cfu/g, while that without oil-spill was 2.03 x 10^4cfu/g for bacteria count; average pH value in polluted soil was 5.28 while that of the control was 5.71; average electrical conductivity polluted soil samples was 78.53 while that of the control was 33.7 while moisture content levels of polluted soils was 18.5% and control 44.7%. Bacteriological analysis revealed the presence of bacteria species including; *Micrococcus, Pseudomonas, Bacillus* and *Aerococcus*. Statistical analysis of results through the Duncan Multiple range test showed significant differences for microbial populations, electrical conductivity and moisture content of oil polluted soil and the control area (unpolluted) with no significant difference in pH of both polluted and non-polluted soils. It is then concluded that oil spills on the soils of Awoye is detrimental to the microbial population of the soil as it alters negatively the physico-chemical properties of the soil thereby lowering its microbial load and also render the soil and water unfit to support life supporting activities of man.

Keywords: Oil pollution, Bacteriological analysis, Physicochemical Parameters, soil, water.

INTRODUCTION

Pollution can be broadly defined as the introduction by man directly or indirectly of substances or energy into the environment resulting in deleterious effects of such a nature as to endanger human health, harm living resources and ecosystems and impair or interfere with amenities or other legitimate uses of the environment [1]. One major pollutant that has aroused public and research interest is crude oil [1]. Pollution by crude oil usually occurs as spillage that is uncontrolled, release of crude oil into the environment as a result of equipment failure, operational mishaps, or intentional damage to facilities [2].

An oil spill according to Osuji [1], is a release of a liquid petroleum hydrocarbon into the environment due to human activity, and is a form of pollution. Oil-spill pollution is hazardous and problematic worldwide [3].

The term often refers to marine oil spills, where oil is released into the ocean or coastal waters. Oil spills include releases of crude oil from tankers, offshore platforms, drilling rigs and wells, as well as spills of refined petroleum products (such as gasoline, diesel) and their by-products, and heavier fuels used by large ships such as bunker fuel, or the spill of any oily refuse or waste oil. Spills may take months or even years to clean up. Oil also enters the marine environment from natural oil seeps. Most human-made oil pollution comes from land-based activity, but public attention and regulation has tended to focus most sharply on sea going oil tankers [4].

Most people think of marine spills when they visualize an oil spill, but the escape of oil into the soil is a problem on the land as well. Since many human rely heavily on petroleum products such as plastic fuel, and lubricating oil, Oil spillage is an unfortunate by-product of the human way of life [5].

Oil production has contributed to play a dominant role in its economy and has also served as a source of energy to run the nation's economy. Industries cannot function properly without the use of refined petroleum [6]. Easy and faster means of

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transportation would have been impossible without pipelines, even the production of other necessities of man would have been impossible if crude oil was not discovered and exploited. Oil spills have a significant impact on the natural resources upon which many poor Awoye communities depend. Drinking water is polluted, fishing, and farming are significantly impacted, and ecosystems are degraded. Oil spills significant affect the health and food security of rural people living near the facilities. Additionally, oil spills and associated impacts of oil and gas operations have impacted the biodiversity and environmental integrity of the Niger Delta [4]. The oil reduces the soils fertility such that the most of the essentials nutrients are no longer available for plant and crop utilization [7].

Oil spillage on soil properties is as a result of crude oil exploitation, the soil (receptor) is soak up by the oil like sponges and prevents the lenticels of crops to absorb oxygen – hence oxygen starvation [8]. However, the crop withers and dies in large numbers thereby leaving the land barren and unproductive. Recent studies have shown that oil spills lower soil fertility and cause poor growth of plants. As the spill occurs, oil contaminated soils may become anaerobic and reducing conditions can result in increased solubility of iron (Fe) and manganese (Mn) to the extent that these potentially photo-toxic elements are absorbed by roots/plant. High oil concentration on soil not only reduces the amount of water and oxygen available for plant growth, but also interferes with soil-plant – water relationships through direct physical contact (coating of root tissues) thereby adversely affecting plant growth [7].

The Awoye community suffers the dilapidating effects of oil pollution which has destroyed most farmlands and reduced the amount of crop yield. It is averred that these spills create unsatisfactory conditions for plants growth due to insufficient aeration of the soil and the increase in the concentration of heavy metals as these oil penetrates the pore spaces on soil following any spill [9]. Most of the Awoye soil where these spills occur suffers from loss of soil fertility through loss of soil organic matter, leaching of nutrients, loss of the nutrient – laden topsoil, changes in soil – pH, reduction in caution exchange capacity, water logging and other forms of soil degradation are major problems associated with agricultural productivity on the Awoye soil. Soil fertility loss and declining crop yield among others are found to be indirect source of pressure on natural resources and community structure especially among the Awoye rural poor, germination and growth performance, and yield of crops in oil impacted soils are stifled [10].

MATERIALS AND METHOD

Study Area

This study is limited to Awoye community situated in Ilaje Local Government Area of Ondo State of Nigeria. The community of Awoye consists of three quarters and Oil wells, namely; Metelewawon, Ebiesuwa, Ebighami the study quarters was Metelewawon, and Oil well 8, Awoye village is situated between latitudes 5°91'55" N. and longitudes 4°97'91" E. It is located in the Southern part of Ondo State very close to the Atlantic Ocean. The area is occupied by the Ilajes in linear settlements along the coast with a fast growing population most of whom utilize the water for various purposes.

The unpolluted soil used as the control samples were collected from the Ondo State University of Science and Technology (OSUSTECH), Farmland about 3 km away from the point of impact where there are neither car repairs nor commercial activities, with no drainage influence and no likelihood of from used motor oil. The study site geographically lies between latitude 6°27'34" N and longitude 4°45'55" E.

Sample Collection, preparation and preservation

A total of Nine (9) soil samples were collected at depth, 0-10 cm, 10-20 and 20-30 cm, were collected from both sites, Six (6) from oil-impacted areas; Metelewawon and Oil well8 in Ilaje LGA, Ondo State, Nigeria and three (3) from the University Permanent site. Samples were collected directly into an aluminum foil paper using sterile spatula stored in sealed polythene bags properly labelled and transported immediately to the Microbiology laboratory of Ondo State University of Science and Technology, Okitipupa where Microbiological and Physiochemical analysis were carried out. They were further preserved in the refrigerator prior to analyses.

Laboratory Analyses

Bacteriological analysis

The samples were microbiologically analyzed using the pour plate technique for total bacteria count with standard method. Nutrient agar medium was used for the enumeration of bacteria in the samples. The visible colonies on the plates were recorded, based on the dilution factor used, 10^3 was used.

PHYSICOCHEMICAL ANALYSIS

Determining the pH value

The pH of the soil was determined using the pH meter glass electrode. Twenty grams of the soil sample were weighed and suspended in 20ml of distilled water and properly stirred (1:2:5). The pH meter was calibrated using buffer solution at pH 7 pH 4 before taking measurements. pH meter was dipped inside the solution to obtain readings.

Determining the Electrical conductivity *(EC)*

Electrical conductivity (EC) was determined using the same method with pH but with a different instrument which is called conductivity.

***Determining the Moisture Content** (MC)*

Moisture Content (MC) was determined using the Oven drying method. A known amount of soil sample was placed in a weighed crucible and dried at 105°C in the oven until a constant weight was reached. From the difference in weight, the percentage moisture content was calculated.

STATISTICAL ANALYSIS

Data obtained were subjected to statistical analysis in other to further confirm the findings made. In doing this, the Duncan's Multiple Range Test (DMRT) was used to test if the parameters of the polluted soil in the study area and the control area were statistically significant.

RESULT AND DISCUSSION

Table-1: Microbial population

Sample point	Depth (cm)	Cfu/ml
AWOYE(Polluted) Metelewawon	0-10 10-20 20-30	1.2×10^4 1.05×10^4 0.9×10^4
Oil well 8	0-10 10-20 20-30	1.05×10^4 0.93×10^4 0.85×10^4
Mean average	…….	9.9×10^3
CONTROL (Unpolluted) Osustech farm	0-10 10-20 20-30	2.0×10^4 1.8×10^4 2.3×10^4
Mean average	…….	2.03×10^4

DISCUSSION

From the data obtained, the microbial population of the of crude oil polluted soil was found decreased in contrast to control soil. In the affected soil the average microbial count was (9.9×10^3) while in the control soil samples was (2.03×10^4), this could be due to the oil pollution becoming, with time concentrated in the lower soil strata. Furthermore, at that depth it is protected from the effects of dissipation factors such as sunlight, temperature and wind, thus toxic effect would be pronounced upon soil microbial inhabitants. Similar report has been obtained by Ojumu *et al.*, [11] who reported that microbial population is lower in polluted soils, than those of unpolluted soils. Difference in microbial population is a reflection of many factors such as physical factors - pH, temperature, oxygen, moisture content, hydrostatic pressure and osmotic pressure and nutritional factors - chemical requirement, trace elements and organic growth factor [12]. The slight difference in bacterial population of oil-spilled soil and non-oil spilled soil may be due to the effect of slight increase in the acidity of the soil spilled with petroleum oil.

Physico-chemical analysis

The physico-chemical properties of oil polluted soil collected from Awoye community, and unpolluted (control) from Osustech, Farm Okitipupa Ondo state are presented in the table below

Table-2: Physico-chemical properties of the Soil

Sample point	Depth(cm)	pH	Electrical conductivity(µs/cm)	Moisture content (%)
AWOYE (polluted)				
Metelewawon	0-10	5.43	55.6	25
	10-20	5.33	60.6	20
	20-30	5.25	90	15
Oil well 8	0-10	5.28	75	20
	10-20	5.24	89	17
	20-30	5.18	101	14
Mean average	…...	5.28	78.53	18.5
CONTROL (unpolluted)				
Osustech farm	0-10	5.66	40.3	55
	10-20	5.77	34	46
	20-30		27	33
Mean	------	5.71	33.7	44.7

DISCUSSION

Soil pH

From the data obtained, the average pH value in samples analysed in Metelewawon area was 5.23 and that obtained in Oil well 8 was 5.34, both values showing that the soils in these areas are more acidic compared to the pH in Osustech farm which has the average value of 5.76. The soils were all slightly acidic and this acidity cannot be attributed entirely to the oil spillage since the non-oil affected soil was equally acidic. However, the oil affected soils have lower pH values (more acidic) than the non-oil affected soils. A pH value between 6.5 and 7.5 is considered optimum for the growth of many plants [9]. Though the oil polluted is slightly acidic to that of the control, the oil pollution may have had some direct impact in reducing the pH of the soil; it might also be due to the production of organic acids by microorganism during degradation of organic pollutants [13, 14]. Also in agreement with the report of Ejileugha *et al.*, [15] who reported that the decrease in pH value in the polluted may be due to increase in degradation of crude oil by microorganisms in the soil resulting in accumulation of acidic metabolites

Electrical Conductivity (EC)

Electrical conductivity of crude oil polluted soil was found increased in contrast to control soil. In the affected soil the average electrical conductivity was (78.53 µS/cm) while in the control soil samples was (33.7µS/cm), The high value of electrical conductivity of crude oil polluted soil may refer to a high presence of charged ions (cations, and anions) in the soil [9]. The value of electrical conductivity represents the ratio of soil salinity, so the key to determine salinity of soil is to obtain the electrical conductivity.

Moisture Content

It was found from table 2 that the moisture content in the oil polluted site have average 18.5% of Compared to the values obtained from Osustech farm location (unaffected by oil spill) from the data obtained which was 44.7%. There is reduction in moisture content of the polluted sites. This may be due to the fact that crude oil can coat the soil and consequently prevent the penetration of water [16].

The reduction in moisture content of the oil impacted sites can be attributed to the inability of water to penetrate the soil due to blockage of the pore in which oil has sinks through, through which water can penetrate. This is in line with [1], reported that soils develop severe and persistence water repellency following contamination with crude oil.

STATISTICAL ANALYSIS RESULTS

Table-3: Statistical analysis Moisture content

Depth (cm)	Polluted(A)	Polluted(B)	Control(C)
0-10	25	20	55
10-20	20	17	46
20-30	15	14	33
Mean average	20	17	44.7

1. The difference between the mean is greater than the Q value ; therefore there is significant differences between polluted and the control
2. The differences between the mean is lower than the Q value; therefore there is no significant differences between the two polluted sites.

Table-4: Statistical analysis of pH

Depth (cm)	Polluted(A)	Polluted(B)	Control(C)
0-10	5.43	5.28	5.66
10-20	5.33	5.24	5.77
20-30	5.25	5.18	5.84
Mean average	5.34	5.23	5.76

1. The difference between the mean is greater than the Q value; therefore there is no significant differences between polluted and the control
2. The differences between the mean is lower than the Q value; therefore there is no significant differences between the two polluted sites.

Table-5: Statistical analysis Microbial population

Depth (cm)	Polluted(A)	Polluted(B)	Control(C)
0-10	12.0	10.5	20.0
10-20	10.5	9.3	18
20-30	9.0	8.5	23.0
Mean average	10.5	9.4	20.3

1. The difference between the mean is greater than the Q value; therefore there is significant differences between polluted and the control
2. The differences between the mean is lower than the Q value; therefore there is no significant differences between the two polluted sites.

Table-6: Statistical analysis on Electrical conductivity

Depth (cm)	Polluted	Polluted	Control
0-10	55.6	75	40.3
10-20	60.6	89	34
20-30	90	101	27
Mean average	68.73	88.3	33.7

1. The difference between the mean is greater than the Q value; therefore there is significant differences between polluted and the control
2. The differences between the mean is lower than the Q value; therefore there is no significant differences between the two polluted sites.

CONCLUSION

It can be concluded that the test results obtained from the soil analysis of the oil-spilled polluted sites (Metelewawon and Oil well 8) compared to the result of the unpolluted site (Osustech Farm) shows there was significant difference in Microbial population, Electrical conductivity values between the oil affected and control sites. More also, the Moisture values for the oil spilled affected areas reduced significantly when compared to Osustech farm (control).The study has vividly revealed that crude oil pollution in the Awoye community, Ilaje LGA, Ondo State, Nigeria has really affected the soil Bacteriological (Microbial load) and Physicochemical parameters (pH, Electrical conductivity, and Moisture content) negatively.

Measures should therefore be taken to prevent further oil spillage in the area while efforts should be concerted at eradicating the oils spills that is already in the soil and waters of Awoye community.

The activities of microorganisms, especially beneficial microorganisms are so important to nutrient release to crops/vegetation grown on a particular soil hence the need for avoidance of pollution and contamination of soil is vital. Petroleum products are very toxic to living organisms in soils which indirectly control the chemical and biochemical activities in soils for plant nutrition.

REFERENCES

1. Osuji, L. C., & Opiah, U. C. (2007). Hydrocarbon contamination of a terrestrial ecosystem: the case of Oshire-2 oil spill in Niger Delta, Nigeria. *The Environmentalist*, *27*(3), 337-340.
2. Okereke, G. U., Onochie, C., Onunkwo, A., & Onyeagba, E. (2001). Effectiveness of foreign bradyrhizobia strains in enhancing nodulation, dry matter and seed yield of soybean (Glycine max L.) cultivars in Nigeria. *Biology and Fertility of Soils*, *33*(1), 3-9.
3. Okereke, J. N., Obiekezie, S. O., & Obasi, K. O. (2007). Microbial flora of oil-spilled sites in Egbema, Imo State, Nigeria. *African Journal of Biotechnology*, *6*(8).
4. Nwilo, P. C., & Badejo, O. T. (2001). Impacts of oil spills along the Nigerian coast. *The Association for Environmental Health and Sciences*, *10*(2), 140-192.
5. Deacon, B. (2007). *Global social policy and governance*. Sage.
6. Baghebo, M., Samuel, U. P., & Nwagbara, E. N. (2012). Environmental damage caused by the activities of multinational oil giants in the Niger Delta region of Nigeria. *Journal of Humanities and Social Sciences*, *5*(6), 09-13.
7. Abii, T. A., & Nwosu, P. C. (2009). The effect of oil-spillage on the soil of Eleme in Rivers State of the Niger-Delta Area of Nigeria. *Research journal of environmental sciences*, *3*(3), 316-320.
8. Oyedeji, A. A., Adebiyi, A. O., Omotoyinbo, M. A., & Ogunkunle, C. O. (2012). Effect of crude oil-contaminated soil on germination and growth performance of Abelmoschus esculentus L. Moench—a widely cultivated vegetable crop in Nigeria.
9. Oyem, A., & Castagna, J. (2013). Layer thickness estimation from the frequency spectrum of seismic reflection data. In *SEG Technical Program Expanded Abstracts 2013* (pp. 1451-1455). Society of Exploration Geophysicists.
10. Aghalino, S. O. (2000). Petroleum Exploitation and Environmental Degradation in Nigeria. *Contemporary Issues in Environmental Studies. Pg*, 141-146.
11. Ojumu, T. V., Yu, J., & Solomon, B. O. (2004). Production of polyhydroxyalkanoates, a bacterial biodegradable polymers. *African journal of Biotechnology*, *3*(1), 18-24.
12. Haris, J., & Loretto, M. (2001). *U.S. Patent Application No. 09/727,121*.
13. Olukoya, D.K., Idika N. and Odugbemi,T. (1993). Antimicrobial activity of some medicinal plants from Nigeria. *J. Ethnopharmacol*. 39: 69-72.
14. Okoye, C. O., & Okunrobo, L. A. (2014). Impact of oil spill on land and water and its health implications in odu-gboro community, sagamu, ogun state, nigeria. *World J Environ Sci Eng*, *1*(1), 1-21.
15. Bessada, S. M., Barreira, J. C., & Oliveira, M. B. P. (2015). Asteraceae species with most prominent bioactivity and their potential applications: A review. *Industrial Crops and Products*, *76*, 604-615.
16. Ijah, U. J. J., & Antai, S. P. (2003). Removal of Nigerian light crude oil in soil over a 12-month period. *International biodeterioration & biodegradation*, *51*(2), 93-99.

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