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Health Implication of Physicochemical Properties of Sump Oil Polluted and Remediated Soil

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ABSTRACT

Physicochemical properties of sump oil polluted and remediated soil were studied. Five (5kg) of soil was polluted with different concentrations (00, 50, 150 and 300 ml) of sump oil. The physiochemical properties of these soils were analyzed before pollution and after pollution using standard analytical procedures. The result of physicochemical parameters of the unpolluted, polluted and treated soils show significant (P≤0.05) increase which are as follows: organic carbon%: (0.97,1.69-2.15, 0.8-1.49) organic matter%: (1.68, 2.92-3.71, 1.3-2.57)Total exchangeable acidity (0.5, 1.2-1.4, 0.5-1.1) Total nitrogen content mol/kg:(0.08, 0.14-0.18, 0.06-0.12), Cataion exchange capacity(3.14, 4.18-5.17, 3.78-5.76) Calcium content mol/kg:(1.2, 1.6-2.6, 1.4-2.6),Potassium mol/kg:(0.18,0.18-0.22, 0.17-0.26) show significant (P≤0.05) decrease for PH:(5.65, 4.11-4.31,5.67- 7.2) and magnesium mol/kg: (5.25,1.86-2.66, 4.26-7.63) The study concluded that sump oil pollution significantly changes the physicochemical properties of the soil and hence impacts it negatively. Treatment with house hold waste remediated the polluted soil and reversed most of the negative impact of the pollution.

Keywords : Remediation, Pollution, Sump- Oil, House-Hold, Waste

I. INTRODUCTION

Oil pollution in Nigeria is a major source of concern to people especially those living in the crude oil rich-areas (Ohanmu et al., 2017). Pollution from sump oil is one of the biggest environmental problems in Nigeria. Engine oil is a petroleum product used to minimize the friction between engine surfaces. It is production is by vacuum distillation of crude oil (Kalichesvky and Peters, 2010).It contains chemical additives like amines, phenols, benzene, calcium, zinc, barium, magnesium, phosphorus, sulphur, and lead (Obidike, 2015).Sump oil is a product from automobile mechanic shops or electrical engine

repairer workshops after servicing the vehicles engines, generating set and other types of machines. It is usually recognized by its dark brown to black colour. It is harmful to the soil environment. It chiefly made up of mixture of different chemicals including low to high molecular weight carbon compounds, lubricants additives, decomposition products and heavy metals which are poisonous to the soil and human health (Adedokun and Ataga, 2014).

Nigerians consumes more than 87 million liters of lubricant annually and adequate attention has not been given to its proper disposal (Obidike, 2015).Disposal of the lubricant into gutters, water drains, open vacant plots and farms is a common practice in Nigeria. This mode of indiscriminate disposal of the sump oil increases pollution incidents in our environment and it has been proved to be more widespread than crude oil pollution (Atuanya, 2014). This leads to the pollution of streams and rivers as well as underground water and agricultural land thereby depleting the mineral resources used by plants for proper growth and development (Desong, 2010).Various specific changes in soil properties occur in the physical, chemical and microbiological content of soils contaminated with lubricant oil. Oil may displace air and water thereby leading to anaerobic conditions in soil. The presence of lubricant oil in soil increase bulk density, decrease water holding capacity and aeration propensity (Obidike, 2015). There are also reports of reduced nitrogen, phosphorus, potassium, magnesium, calcium, sodium and increased levels of heavy metals in soils contaminated with oil.

1.1 EFFECTS OF SUMP OIL ON SOIL

Sump oil contaminated soils has been reported to affect the soil properties. The effects of sump oil on soil indicated that the pH status, carbon content, total nitrogen, available phosphorus, cation exchange capacity, among others were impacted negatively depending on the level of pollution exposure, Atlas, R.M. (2005). Study of Amadi et al. (2013) reported that most soil properties were adversely affected in oil-contaminated lands. It has been observed that the effect of sump oil and other pollutants on soil chemical properties was determined by the following: Soil pH, temperature, supply of oxygen, the structure of the contaminant molecules, their toxicity and that of their intermediate decomposition products. Petroleum products adversely affect biological systems and particularly, the soil health status (Henery and Hershey, 2002).One of the biggest concerns associated with crude oil pollution in the environment is the risk to farmland, and potable drinking water contamination (Ohanmu et al., 2017).

The effect of oil pollution range from disruption of plant water relations, direct impact to plant metabolism, for instance, nutrient uptake, toxicity to living cells for example the liquid component of the protoplasm, reduced oxygen exchange between the atmosphere and the soil affecting root function to reduction in biomass (Ohanmuet al., 2018). The soil health is the continued capacity of the soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain biological productivity, promote the quality of air and water environments and maintain plant, animal and human health. Several bio-indicators of soil health and quality have been developed and reviewed (Henery and Hershey, 2002).

1.2 BIOREMEDIATION

This is a natural way of treating, managing, or removing environmental contaminants from its environment. Bioremediation of soils is fast becoming an important alternative to chemical treatment. Wang et al., (2000) Remediation of sump oil polluted soil can be done using Ash generally called surfactants. Surfactant (Ash) improves the availability of contaminants for degradation by microorganisms. They act by partitioning preferentially at interphase and exhibiting high surface and emulsifying activities (De Song, 2010). The addition of organic matter to sump oil contaminated soil have also been reported to be beneficial, as it is a source of co-substrates,

nutrients and microorganisms, and ameliorates the chemistry and water-retaining capacity of the soil (Adekunle et al., 2012). The use of fresh organic materials for amendment such as Vegetables to incubate with the contaminated soil produces a thermophilic phase and the process is called composting (Fagbemi et al., 2005).

Leaves of plant have shown usefulness in remediation of crude oil contaminated soils by Increase in organic carbon and organic matter of crude oil contaminated soil. Remediation of oil polluted soil using peels may impact bio stimulation efficiency on the soils and so lead to reduction in hydrocarbons and increasing the bacteria load of the soil. This may be due to the biodegradation by nutrient additions or other processes such as volatilization (Nunes et al, 2020).Peels which are often disposed indiscriminately is a carbon source in bioremediation of polluted soil. It can be used as adsorbent and as a filter medium for mine water. (Ayansian et al., 2014).Cassava peel is an agro-industrial waste that is discarded in Nigeria, yet it is good organic manure. It may be used in the treatment of contaminated soil. The peel enhances aeration and increases the water-retaining capacity of the soil, thus promoting bioremediation (Henery and Hershey, 2002).

II. MATERIALS AND METHODS

2.1 Collection of samples

Sump oil (S0) was collected from different Mechanic workshop close to the Army Barracks (distance 465.01m) Obinze in Owerri West Local Government Area, Imo State. The sump oils were pooled together.

The unpolluted soil was collected (0-6cm) from the forest reserve (Latitude: 5.417 o and Longitude; 7.0094o) in Imo State Polytechnic Umuagwo, in Ohaji Local Government Area of Imo State. The wood ash was collected from Imo State Polytechnic and environs (Laltitude:5.3342o and Longitude;6.9545o). Peels and vegetables were collected from Eke Umuagwo Market,(Latitude 5.3062 o and longitude 6.9436 o).

2.2. Pollution of soil samples

The soil was sieved using a 2.0 mm sieve in which contaminants were removed and properly mixed. Then, 5.0 kg of this soil sample was weighed and put into 12.0 different (25.0 by 40.0 cm) polythene bags and grouped into 4 with 3 replicates. Each replicate was polluted with different volumes of sump oil (0ml, 50ml, 150ml and 300ml) as shown in the Table 1.0 below and allowed undisturbed for 48 hours. Aliquot of 50.0g each of the unpolluted and polluted soil samples were taken to the soil laboratory of the department of Soil Science, Federal University of Technology Owerri, for analyses.

Table 1.0 Experimental Design, treatment of replicates with domestic waste

SAMPLE	CODE	REPLICATE
5kg of Soil + 00ml sump oil	A(control)	3
5kg of Soil + 50ml Sump oil	B	3
5kg of Soil + 150ml Sump oil	C	3
5kg of Soil + 300ml Sump oil	D	3

2.3: TREATMENT WITH HOUSE-HOLD WASTE (ASH, PEELS AND VEGETABLE WASTE)

After 72 hours, the polluted soil sample replicates where treated separately with the waste; 1.0kg of wood ash, 1.kg of vegetables (50% pumpkin and 50%

water leaf), 1.0 kg of peels(50% cassava and 50% yam) respectively as shown in table 4, thoroughly mixed, and allowed for two weeks for the waste to properly decay. The treated soil replicates were properly mixed and 50.0 g each were sampled and taken for laboratory analyses.

2.4: Laboratory analysis

Physicochemical analysis were done using standard analytical procedure described by Nwakaudu et;al 2012 and Blake, 1986. The soil samples were delivered to the laboratory in polythene bags for analysis. The soil samples were made into three replicates for the analysis.

2.4.1. Soil Analysis Procedure

Soil pH

Soil pH was measured using the Labtech pH meter. The meter was standardized first with buffer 9.2 and buffer 4.0 respectively. Air-dried soil (20.0g) was passed into a 50.0ml beaker and 20.0ml of distilled water was added to it. The suspension was stirred several times with a glass rod for 30.0 minutes. The electrode of the pH meter was inserted into the suspension and the pH was measured in a soil-water ratio.

ORGANIC CARBON DETERMINATION

Walkley-Black method was used. Soil (1.0g) was weighed and placed in the 250.0ml flask and 10.0ml of 1.0N K2CrO7 solution was pipetted accurately into each flask and swirled gently to disperse the soil. Concentrated H2SO4(20ml) was added rapidly from a measuring cylinder and immediately swirled and allowed to stand on a sheet of asbestos for about 30.0minutes, 100.0ml of Distilled water was added and allowed to cool down. 5.0ml of O-phosphoric acid was added to sharpen the colour change of the end point. An indicator (4 drops) was added and titrated with 0.5N Ferroussulphate solution on a white background.

SOIL ORGANIC MATTER (SOM)

Measurement of SOM was carried out with approximately 10.0 g of air-dry soil. The Soil was placed in a 30.0 mL porcelain crucible (5.0cm diameter, 2.5cm height), this was dried in a convection oven at 105.0°C, and placed in a sealed desiccator to cool. These processes were repeated until the soil and crucible acquired a constant weight. Later a muffle furnace was preheated to 360.0°C and soil was heated in the furnace at that temperature for 2.0 h. After 2 .0h, the crucible with soil was removed from the furnace and placed in a desiccator to cool before being weighed. The difference in the weight of the crucible and soil pre-heating and post-heating was assumed to be the weight of SOM in the sample. A select number of samples were analyzed for SOM content multiple times to check repeatability of the results,, and the measured SOM content of the samples was consistent for repeated number of analyses within 0.4 g SOM kg–1, which is less than a 3.0% difference in measured SOM.

TOTAL EXCHANGE ACIDITY DETERMINATION

The method used was KCl extraction method. Air dried soil (5.0g) was weighed into 50.0ml centrifuge tube and 30.0ml of M-KCl was added and shaken. The content was centrifuged for 15.0min and clear supernatant was decanted into 100.0ml volumetric flask. Another 30 ml of M-KCL was added to the same soil sample and shaken for 30.0mins. KCl extract (5.0ml) was pipetted into a 250.0ml Erlenmeyer flask and 100.0ml of distilled water was added. 5.0 drops of phenolphthalein indicator was added and titrated with 0.01M NaOH.

TOTAL NITROGEN DETERMINATION

The method used was Regular macro Kjeldhal method. Soil sample (2.0g) was weighed into Kjeldhal flask and 20.0ml of distilled water was added. The flask was swirled for few minutes and allowed to stand for 30.0minute before 2.0g of catalyst and 20.0ml of Conc H2SO4 were added and heated continuously on a low

heat. The flask was allowed to cool and slowly with shaking, 5.0ml of distilled water was added and the digest was transferred into another clean flask. 10.0ml of H3HO3 solution was added into a 50.0ml Erlynmeyer flask, which is then placed under the condenser of the distillation apparatus. NaOH (10.0ml of 40.0%) was added slowly into 10.0ml of digest in the flask which has been attached to the distillation apparatus. Temperature was raised until it boiled. Distillate (50.0ml) was collected and distillation was stopped. Ammonia liberated was titrated with standard HCl after 3 drops of indicator was added.

CATION EXCHANGE CAPACITY DETERMINATION

Air dried soil (10.0g) was weighed into 500.0ml Erlenmeyer flask and 40ml of neutral 1.0N NH4O was added. The soil was leached with the neutral 1.0N NH4O reagent until no test for calcium can be obtained in the effluent solution (for calcium test add few drops 1.0N NH4O, 10.0% ammonium oxalate, and dilute NH4OH to 10.0ml of the leachate in a test tube and heated to near the boiling point. The presence of Ca is indicated by a white precipitate or turbidity). The leachate was preserved for the determination of exchangeable cation (EC determination k, Ca, & Mg). The electrolyte was washed out with 170.0ml of 99.0% ethyl alcohol.

The soil was transferred and filtered to 500.0ml kjeldahl flask. Distilled water (200.0ml) and two drops of liquid paraffin were added. The solution (60.0ml) was distilled into 50.0ml of 2.0% boric acid solution and measured into 250.0ml of Erlenmeyer flask. 10.0 drops of bromocresol green-methyl red mixed indicator was added and the NH4-borate was titrated with standard 0.02N H2SO4. The blanks were run on the reagents and the titer was corrected with blank result.

Ca, Mg and K DETERMINATION

The leachates preserved from CEC determination were used for the determination of Ca and Mg with AAS and K with a flame photometer.

III. RESULTS AND DISCUSSION

The physico-chemical analysis carried out in this study before and after pollution with sump oil, showed that there was reduction in the pH of the contaminated soil compared to control soil samples. Although the pH of the control soil was not within the pH value between 6.5 and 7.5 considered optimum for the growth of many plants (Marschner, 2005), increase in acidity after the pollution was recorded. Soil pH is a major factor in the accessibility of elements in the soil for plant uptake (Marschner, 2005). Okon and Udofot (2012) reported that petroleum waste sludge adversely reduce microbial population by depleting essential inorganic nutrients and growth factors. Kayode et al (2009) noted reduced nitrogen, phosphorus, potassium, magnesium, calcium, and increased sodium in soils contaminated with oil. The total nitrogen content of the contaminated soil increased compared to the control. This increase in nitrogen content of the contaminated soil, contradicted the report that, in the presence of contamination in soil, the supply of carbon increases and the availability of nitrogen becomes limited (Atlas, 2005). Calcium, magnesium and potassium increased considerably in the presence of sump oil in the contaminated soil samples. Magnesium is very essential for the integrity of functional ribosomes (Chang and Hayes, 2014). There was increase in the available magnesium content in the sump oil contaminated soil samples compared to the control. An increase in the organic carbon and organic matter was also observed in the contaminated soils which definitely must have resulted from the application of the sump oil. Crude oil, from which sump oil was derived, contains principal elements such as oxygen, nitrogen, other than hydrogen and carbon (Obidike,

2015). Spillage of used motor oils such as diesel pollutes the natural environment with hydrocarbon (Amadi et al., 2013).

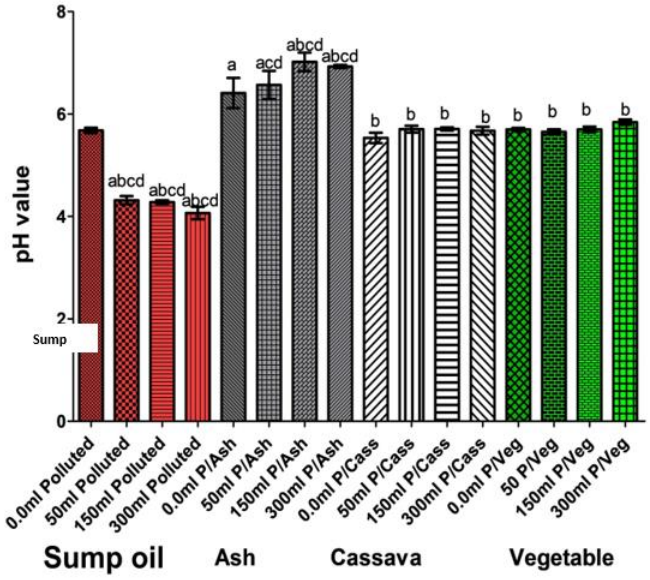

Figure 3.1 : Effect of the different concentration sump oil pollution on soil pH in different treatment with ash, cassava and vegetables.

The PH of the soil before pollution was 5.65 while sump oil pollution reduced to 4.11-4.31 after pollution. The treatment with household waste increased it again to 5.67- 7.20.

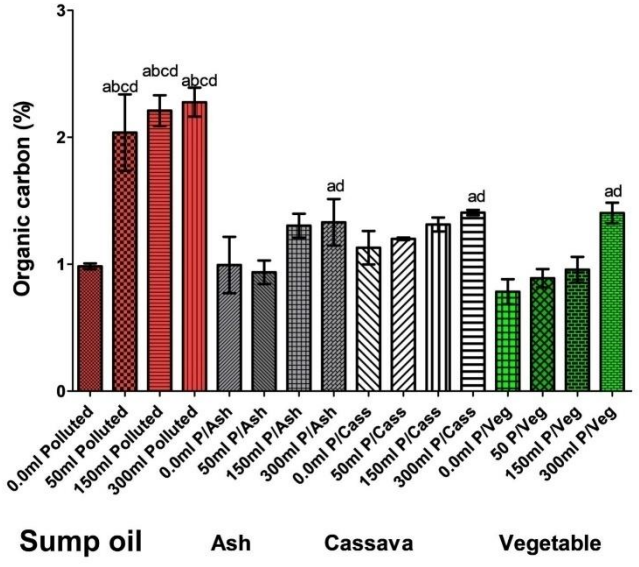

Figure 3. 2 : Effect of different concentrations of sump oil polluted soil on organic carbon content in different treatment with ash, cassava and vegetables.

The result above shows that Organic carbon content of soil was increased with increase in pollution with sump oil compared to control soil. The different treatments decreased concentrations down to within the control level.

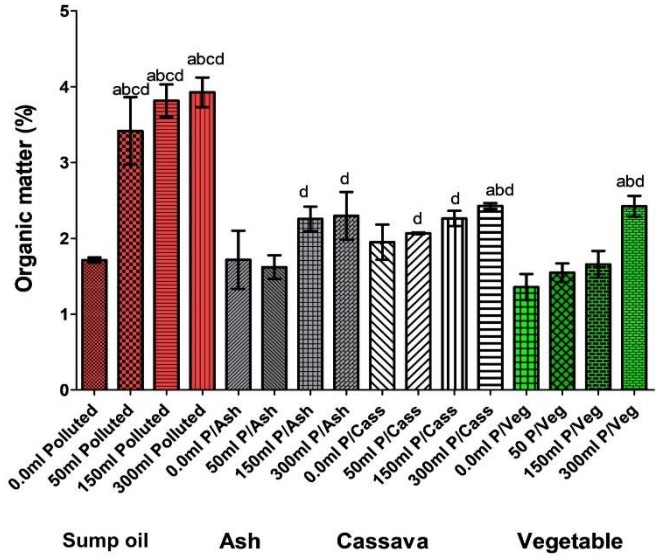

Figure 3.3 : Effect of sump oil pollution on organic matter content of different
Concentration SO in different treatment with ash, cassava and vegetables

Organic matter content of soil was increased with increase in pollution with sump oil compared to control soil. The different treatments decreased concentrations down to within the control level.

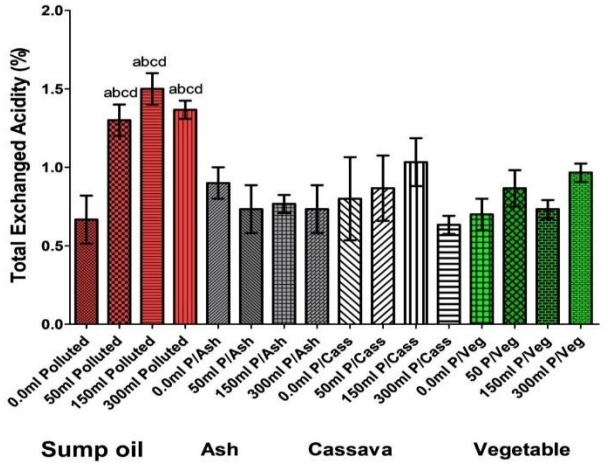

Figure 3.4 : Effect of sump oil pollution on total exchanged acidity content of sump oil polluted and treated soil samples.

Total exchange acidity content of soil was increased with increase in pollution with sump oil compared to control soil. The different treatments decreased concentrations down to within the control level.

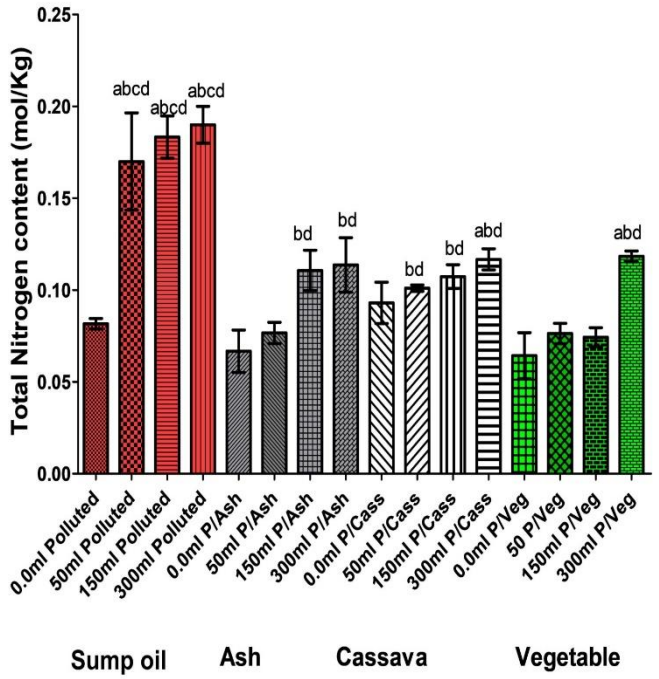

Figure 3.5 : Effect of sump oil pollution on total nitrogen content of soil samples

Total Nitrogen content of soil was increased with increase in pollution with sump oil compared to control soil. The different treatments decreased concentrations down to within the control level.

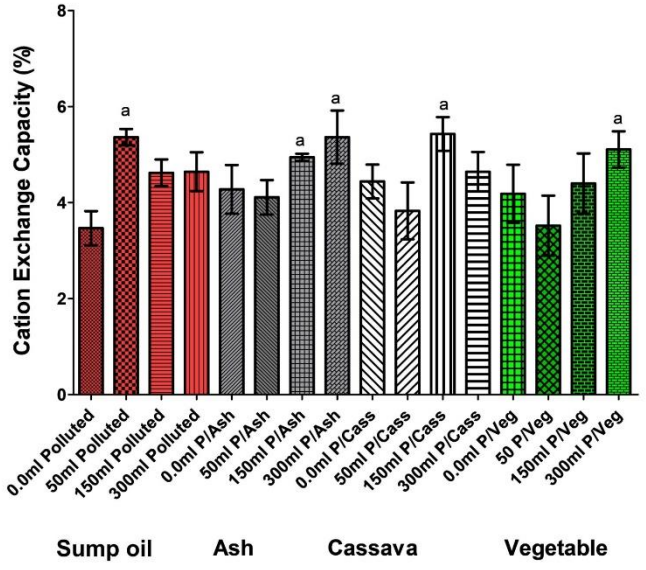

Figure 3.6 : Effect of sump oil pollution on cation exchange capacity of sump oil polluted and treated soil samples.

Cation exchange capacity of soil was increased with increase in pollution with sump oil compared to control soil. The different treatments did not show significant reduction.

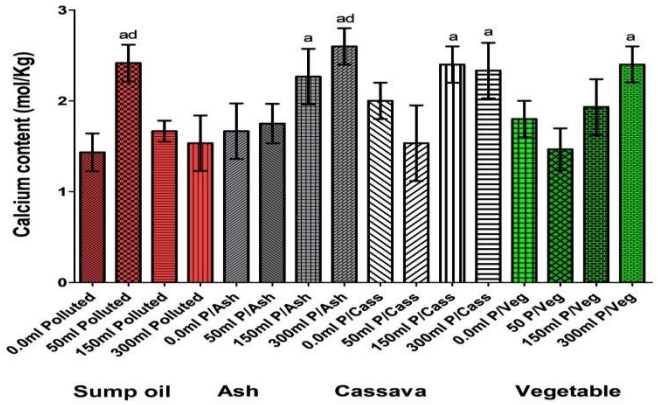

Figure 3.7 : Effect of sump oil pollution on calcium content of sump oil polluted and treated soil samples.

There was no significant change on the calcium of unpolluted, polluted and treated soil samples.

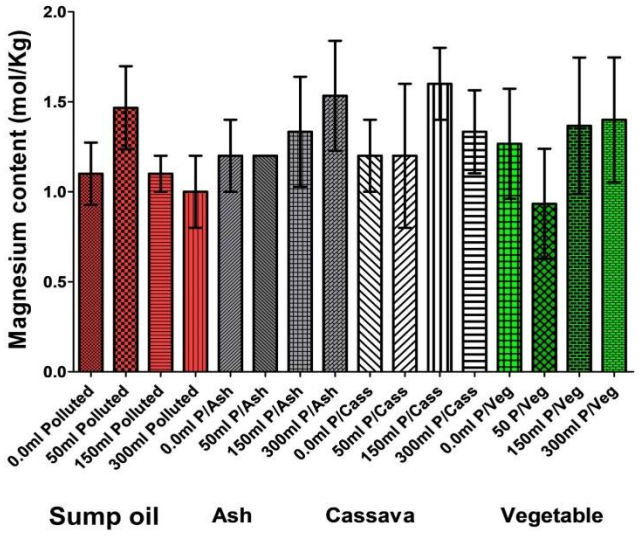

Figure 3.8 : Effect of sump oil pollution on magnesium content of soil samples.

There was no significant change or pattern on the magnesium of unpolluted, polluted and treated soil samples.

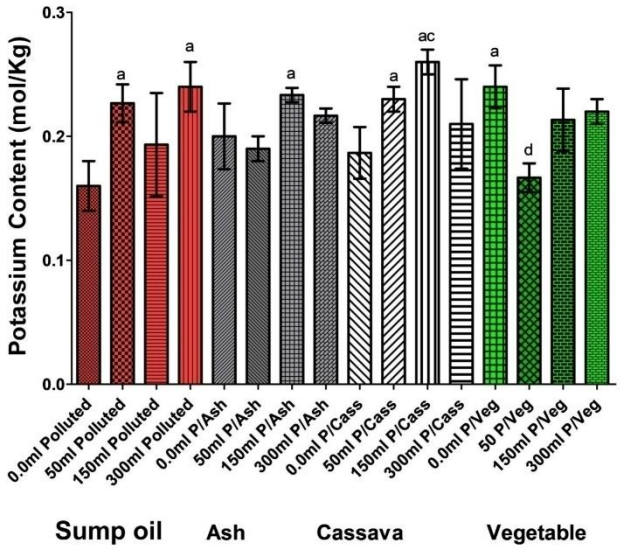

Figure 3.9 : Effect of sump oil pollution and treatments on potassium content of soil samples

The result shows that there was significant increase on the potassium content of soil polluted with sump oil compared with polluted but treated soil samples did not show significant reduction.

IV. CONCLUSION

The physicochemical analysis carried out on this study before and after pollution with sump oil and subsequent treatment with household waste showed that there were significant effects of sump oil pollution on soil properties compared to control soil samples. The health implication of polluted environment through bioaccumulation of sump-oil is seen in the depletion of physicochemical properties and nutrients. The applied household wastes positively increased soil quality. The effect observed with the treatment was a function of oil dose and applied organic household waste type.

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