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HEAVY METALS STATUS OF SUMP OIL POLLUTED AND TREATED SOIL

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ABSTRACT:

The study determined the heavy metals (**Pb**, **Fe,Ar**, **Cd**, **Ni**, and **Hg**), content of different concentration of sump oil polluted soil. Heavy metal status *of* sump oil polluted soil was investigated before pollution, after pollution and after remediation. The soil samples where treated with sump oil concentration of (A: 00ml/5kg, B: 50ml/5kg, C: 150ml/5kg and D: 300ml/5kg) for two week. Thereafter the polluted soil were treated with 1.0kg of wood ash (WA); 1.0kg of vegetables (50% pumpkin and 50% water leaf; P/W from the market), and 1.0 kg of peels (50% cassava and 50% yam; C/Y) respectively for two weeks.

The results showed that there is a dose-dependent, significant (P≤0.05) increase in the different heavy metals concentration of sum oil-polluted soil studied as compared to the control. The control and polluted results (ppm) were Lead (**Pb**)ppm (0.16 ± 0.02 **/** 1.33 ± 0.02); Iron (**Fe**)ppm (2.20±0.04/15.43±0.45); Arsenic (**Ar**) ppm (0.06± 0.01**/** 0.25 ± 0.02); Cadmium (**Cd**) ppm (0.21 ± 0.05/ 2.55± 0.37); Nickel (**Ni**) ppm (0.11± 0.02 **/** 1.84 ±0.08) and Mercury (**Hg**) ppm (0.08 ± 0.01**/** 0.64 ± 0.04). The result of the remediation treatment showed that lead was not significantly (P≤0.05) reduced in all treatments. Cadmium was significantly (P≤0.05) reduced in all treatments while nickel was significantly (P≤0.05) reduced in wood ash treatment only. The study concluded that sump oil exposure to soil can significantly increase the heavy metal status of such soil while treatments with house hold waste can reduce the heavy metal load.

Key words: ***Heavy metals, soil pollution, sump oil, remediation***

I. INTRODUCTION

Heavy metal has harmful effect on biological system and does not undergo biodegradation [8]Pollution from sump oil is one of the environmental problems in Nigeria and is more widespread than crude oil pollution. Sump oil is a petroleum product which is used to reduce the friction between engine surfaces. It is produced by vacuum distillation of crude oil [2]. Nigeria accounts for more than 87 million litres of lubricant annually [5] and adequate attention has not been given to its proper disposal. Disposal of the lubricant into gutters, water drains, open vacant plots and farms is a common practice especially by motor mechanics. In Nigeria, the existing mode of indiscriminate disposal of this waste oil increases pollution incidents in the environment and it has been shown that this is more widespread than crude oil pollution [7]. It has been observed that Nigeria produces more than 87 million litres of spent automobile oil annually and that most heavy metals, such as Va, Pb, Al, Ni and Fe, which are below detection in unused lubricating oil, showed high values in waste automobile oil,[3]. The high percentage heavy metal in used lubricant oil of different sources cannot be overemphasized. Metals present in lubricating oil

are not necessarily the same as those present in the unused lubricant [4]. Heavy metals are the major environmental contaminants and pose a severe threat to human and animal health by their long-term persistence in the environment [6].

Heavy metals metal pollution with soil residence times of thousands of years, pose numerous health dangers to higher organisms. They are also known to have effect on plant growth, ground cover and have a negative impact on soil micro flora. It is well known that heavy metals cannot be chemically degraded and need to be physically removed or be transformed into nontoxic compounds[8].

II. MATERIALS AND METHODS

A. Collection of samples

SUMP OIL (SO) was collected from different Mechanic Village close to army barracks distance 465.005m in Obinze distance in Owerri West Local Government Area, Imo State. The unpolluted soil was collected from the forest reserve Latitude: 5.417 and Longitude; 7.0094 in Imo State Polytechnic Umuagwo, In Ohaji Local Government Area, Imo State. The wood ash was collected from Imo state polytechnic and environs Laltitude: 5.3342 and Longitude; 6.9545. Peels and vegetables were collected from eke Umuagwo market perimeter; 773.719m area; 0.054$m^{2,}$ Latitude 5.3062 and longitude 6.9436.

B. POLLUTION OF THE SOIL SAMPLES

Uncontaminated top soil (0-6cm) was obtained from Forestry Reserve Land in Imo State Polytechnic, Umuagwo. 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 different (25 by 40 cm) polythene bags and grouped into 4 replicates (A, B, C and D). Each replicates was polluted with different volumes of sump oil (0ml, 50ml, 150ml, and 300ml) obtained as pooled sump oil from commercial vehicles at different Motor Mechanic workshops located at Mgbirichi and Umuagwo as designated in the table 2 and 3 below and allowed undisturbed for 48 hours. Aliquot of 50.0g each of the soil samples were taken to the soil laboratory, soil science department, Federal University of Technology Owerri, for analyses.

Table 1.0 Experimental Design; treatment of replicates with domestic waste

S/N	POLYTHENE BAG	SAMPLE CODE	REPLICATE
1	5kg of Soil + 00ml sump oil	Sample A(control)	3
2	5kg of Soil + 50ml Sump oil	Sample B	3
3	5kg of Soil + 150ml Sump oil	Sample C	3
4	5kg of Soil + 300ml Sump oil	Sample D	3

KEY SO- Sump oil, **WL**- Water Leaf **.**The number A represents Control
B represents 50ml Pollution
C represents 150ml Pollution
D represents 300ml Pollution
The number 1, 2, and 3 represents different treatment in triplicates.

C. REMEDIATION OF SOIL SAMPLES

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 wastes to properly decay. The treated soil replicates were properly mixed and 50.0 g each were sampled and taken for laboratory analyses.

Table 2.0 Treatment of replicates with domestic waste

S/N	SAMPLE REPLICATES	TREATMENT
1	Sample A_1 (polluted with 00ml SO) Control	Treated with 1kg ash
2	Sample A_2 (polluted with 00ml SO) Control	Treated with 1kg cassava and yam peels
3	Sample A_3 (polluted with 00ml SO) Control	Treated with 1kg vegetables(pumkin /WL)
4	Sample B_1 (Soil polluted with 50ml SO)	Treated with 1kg ash
5	Sample B_2 (Soil polluted with 50ml SO)	Treated with 1kg cassava and yam peels)
6	Sample B_3 (Soil polluted with 50ml SO)	Treated with 1kg vegetables(pumpkin /WL)
7	Sample C_1 (Soil polluted with 150ml SO)	Treated with 1kg ash
8	Sample C_2 (Soil polluted with 150ml SO)	Treated with 1kg cassava and yam peels
9	Sample C_3 (Soil polluted with 150ml SO)	Treated with 1kg vegetables(pumpkin /WL)
10	Sample D_1 (Soil polluted with 300ml SO)	Treated with 1kg ash
11	Sample D_2 (Soil polluted with 300ml SO)	Treated with 1kg cassava and yam peels
12	Sample D_3 (Soil polluted with 300ml SO)	Treated with 1kg vegetables (pumpkin /WL)

D. DETERMINATION OF SOIL HEAVY METALS

The heavy metals were analyzed with atomic absorption spectrophotometer[12].

Sample preparation and digestion

The different soil samples were air dried and allowed to pass through a 2mm sieve. Five gramss of the soil were weighed into a digestion tube (50ml in volume) and 2ml of HNO_3 and 10 ml of HCl was added to the samples. The content was heated on a digestion block in fume cupboard to dryness at 120°C[1].The residue was allowed to cool and leached with 5ml of 2M HCL. This was placed inside the centrifuge machine for 10 minutes at 4500rpm at 120°C for 1 hour, then increased to 250°C for 1 hour and allowed to cool before making it to volume with ultra-pure water. The extract was later poured into a set of vials for the determination of the different heavy metals.

E. Heavy metal analysis

The digested samples were analyzed for Lead (**Pb**), Iron (**Fe),** Arsenic (**Ar**), Cadmium (**Cd**), Nickel (**Ni**) and Mercury (**Hg**), using atomic absorption spectrophotometer (Buck 205 model Atomic Absorption Spectrophotometer). The wavelength of monochromator used in analysis were as follows; Lead (**Pb**); 240.1 nm, Iron (**Fe); 327.1,** Arsenic (**Ar**);194.8 , Cadmium (**Cd**); 238.8 nm , Nickel (**Ni**); 224.7 nm and Mercury (**Hg**), 253.5. Preparations of samples were done by running several standard of the metal under the same condition as the samples. The concentrations of the metals in the sample solutions were determined using the standard calibration.

F. DATA ANALYSIS

The data were statistically analyzed using SPSS. One way Analysis of Variances (ANOVA) and Turkey's multiple comparison tests were used to compare the concentrations of the metals in the soil samples. P-values are mean significant different ($P < 0.05$).

III. RESULTS AND DISCUSSION

A. HEAVY METALS ANALYSIS RESULT

Results of all the heavy metals studied as compared to the control are presented in figures 1 to 6. Lead (Pb), Iron (Fe), Arsenic (Ar), Cadmium (Cd), Nickel (Ni) and Mercury (Hg) before and after pollution with sump oil showed that there

were significant ($p<0.05$) increase compared to control of soil samples. The remediation treatments response is dependent on organic waste type and concentration.

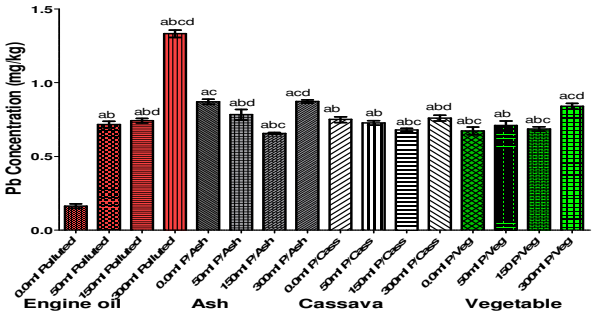

Figure 1: Effect of sump oil pollution on Pb concentration of different of soil samples.

P/Ash – polluted with ash; P/Cass – polluted with cassava; P/Veg – polluted with vegetable.

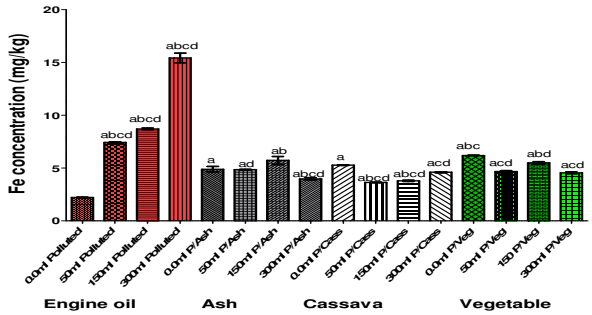

Figure2: Effect of sump oil pollution on Fe concentration of different soil samples.

P/Ash – polluted with ash; P/Cass – polluted with cassava; P/Veg – polluted with vegetable.

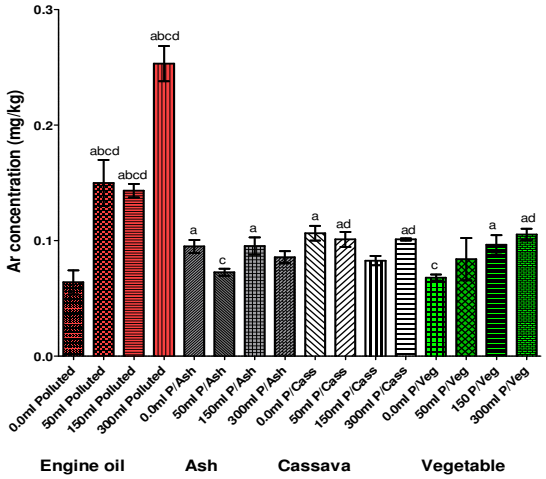

Figure3: Effect of sump oil pollution on Ar concentration of different soil samples.

P/Ash – polluted with ash; P/Cass – polluted with cassava; P/Veg – polluted with vegetable

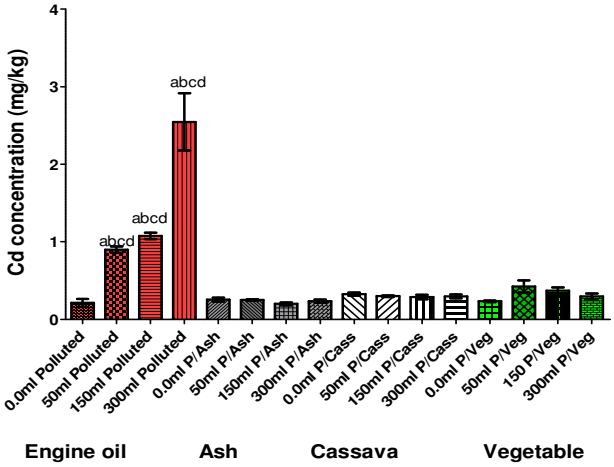

Figure4: Effect of sump oil pollution on Cd concentration of different soil samples

P/Ash – polluted with ash; P/Cass – polluted with cassava; P/Veg – polluted with vegetable

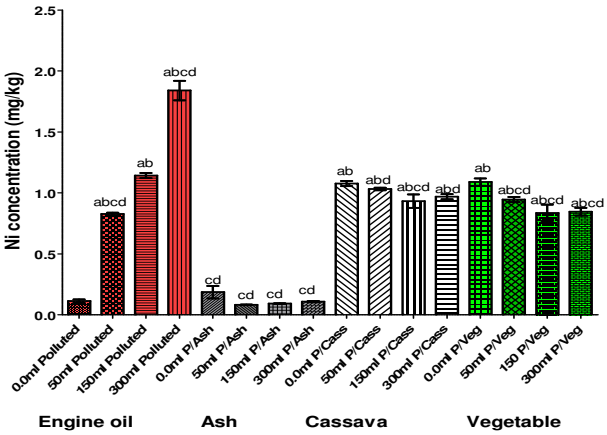

Figure 5: Effect of sump oil pollution on Ni concentration of different soil samples

P/Ash – polluted with ash; P/Cass – polluted with cassava; P/Veg – polluted with vegetable

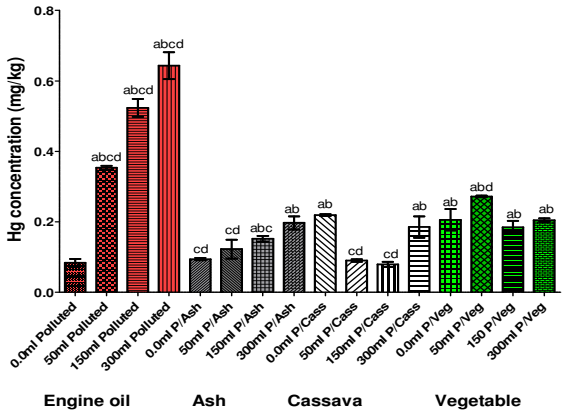

Figure6: Effect of sump oil pollution on Hg concentration of different soil samples

P/Ash – polluted with ash; P/Cass – polluted with cassava; P/Veg – polluted with vegetable

B. DISCUSSION

Heavy metals pose a severe threat to human and animal health by their long-term persistence in the environment[6]. Metal pollution is known to have adverse effect on living organisms and their environment. Bioremediation mechanisms are unique and specific depending on the organisms and contaminants in question[13]. `The natural process of heavy metal treatment, involves biodegradation of environmental contaminants and bioremediation treatment [6, 13] All the heavy metals studied as compared to the control; Pb, Fe, Ar, Cd, Ni and Hg were increased with sump oil pollution and this agreed with report of[11]Spent oil contains a mixture of different chemicals including heavy metals which have been found to be harmful to the soil and human health [10]There are also reports of reduced nitrogen, phosphorus, potassium, magnesium, calcium, sodium and increased levels of heavy metals in soils contaminated with oil. It has been observed that Nigeria produces more than 87 million litres of spent automobile oil annually and that most heavy metals, such as Va, Pb, Al, Ni and Fe, which are below detection in unused lubricating oil, showed high values in waste automobile oil [3]. The high concentration of heavy metals found in used lubricant oil of different sources cannot be over emphasized. The treatment with ash decreased concentrations to appreciable level while vegetable and peels worked only on soil with highest concentration of the sump oil. This is suspected to be due to chelating and dilution effects of these heavy metals. Heavy metals are non-biodegradable and persist in the environment. Hence remediation is required to avoid heavy metal accumulation in environment[13]heavy metals pollution creates environmental stress for human beings, animals and other organisms [9]

IV. CONCLUSION

The study concluded that sump oil exposure to soil can increase the heavy metal status of such soil while treatmentwith house hold waste can reduce the heavy metal load.

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