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Heavy Metals Content of Crude Oil Sludge/Poultry Manure and Crude Oil Sludge/Municipal Solid Waste Composts

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Abstract: Composting of crude Oil production Sludge (OS) differently with Poultry Manure (PM) and Municipal solid Waste (MW) was carried out at John Ker Nigeria Research Site in Ikot Ekpene, Akwa Ibom State, Nigeria, to evaluate the heavy metals content of the cured composts. Each of the two compost combinations (OSPM and OSMW) was homogenously mixed and stored in jute bags using various ratios of 1:1, 1:5, 1:10 and 1:20 volume-volume basis, respectively, for six weeks. The result reveals that the content of heavy metals in the fresh oily sludge and municipal solid waste was similar, but higher than that of fresh poultry manure. Mean contents of essential nutrients such as Zn, Cu Mn and Fe in the among OSPM cured composts were; 270.8, 24.1, 339.6 and 856.5 mg kg^{-1} compared to 286.4, 469.9, 219.73 and 851.0 mg kg^{-1} in the OSMW composts, respectively. There were low mean concentrations of heavy metals such as Vi(6.72), Ni(8.67), Pb(0.004) and Cd(0.001) in the OSPM cured composts, unlike Vi(4.4), Ni(8.2), Pb(61.1) and Cd(3.20) mg kg^{-1}, in the OSMW cured composts. The composting process created a favourable condition for the microbial degradation of the oily sludge, with heavy metals content of the cured composts influenced by the contents of these elements their fresh organic samples used.

Key words: Heavy metal, crude oil sludge, poultry manure, compost, municipal solid waste

INTRODUCTION

Oil extraction and processing operations by various oil companies in Nigeria have culminated in generating large volumes of oily sludge that constitute a severe pollution problem for these industries. Oily sludge denotes the entire chemical compounds that results from the oxidation of the hydrocarbons in the oil or all the materials that may settle as bottom settlings when a tank of crude oil stands stagnant for sometimes. Some constituents of the oily sludge are carcinogenic and potent immunotoxicants (Propst *et al*., 1999). This makes any improper disposal of it to result in environmental pollution especially soil contamination which is a serious threat to underground water.

Earlier researches on management of oily sludge were focused on degradation of the hydrocarbon content of the polluted *in situ* soils using various materials and methods (Mishra *et al*., 1999, 2001; Sarma *et al*., 2004a; 2004b). Various approaches employed in decontaminating sludge-affected sites included; natural attenuation, biostimulation and bioaugmentation as reported by Huesemann and Truex (1996), Al-Awadhi *et al*. (1996), MacNaughton *et al*., (1999). These approaches can be summed up in the modern method of composting organics in windrows.

The physical and chemical compositions of Municipal Solid Waste (MSW) and poultry manure in Nigeria have already been studied and highly recommended for use in composting (Sridhar *et al*., 1985; 1992; 1993; Adeoye *et al*., 1993; John *et al*., 2001; John, 2002; John *et al*., 2006).

Therefore, this research highlights the content of heavy metals in oily sludge composted differently with poultry manure and municipal solid waste using an active national process of degradation to enhance the rate of decomposition process indigenous degrading microorganisms.

MATERIALS AND METHODS

This research was carried out at John ker Nigeria Research site, 112b old Itu Road, Ikot Ekpene, Akwa Ibom State, Nigeria. The oily sludge was obtained from Exxon Mobil, Oil producing Nigeria Unlimited, QIT, Ibeno Local Government Area, while poultry manure was collected from a laying pen under intensive management system at Ritman Farms Ltd., 104 Umuahia Road, Ikot Ekpene. The decomposed municipal solid waste (sorted) was collected from Ikot Ekpene main market dumpsite. The compost treatments were; Oily sludge plus poultry manure and oily sludge plus Municipal Solid Waste (MSW) both mixed at ratios of 1:1, 1:5, 1:10 and 1:20, respectively, using volume/volume basis.

Adequate water was added to each compost heap and thoroughly mixed. The compost treatments were bagged in perforated jute bags and stored under a zinc-roofed shade. Subsequent turnings and watering were done on weekly basis till maturity of the composts.Fresh organic materials and compost samples were collected before each turning for laboratory analysis of the following heavy metals: Zn, Cu, Mn, Fe, Ni, V, Pb and Cd. These elements were determined by extraction with sodium bicarbonate and their concentrations read in the atomic absorption spectrophotometer (Hunter, 1992).

RESULTS AND DISCUSSION

Heavy metals content of fresh oily sludge, poultry manure and municipal solid waste: The content of heavy metals in the fresh oily sludge and decomposed municipal waste were comparatively similar and much higher than same metals in the poultry manure. This is presented in Table 1.

Iron content was highest among all the heavy metals in all the fresh wastes. This might bedue to the fact that Fe is the most abundant element in the earth crust

Table 1: Heavy metals content of fresh oily sludge, poultry manure and municipal solid waste used in composting

	Heavy metals (mg kg^{-1})							
Organic material	Zn	Cu	Mn	Fe	Ni	V	Pb	Cd
Oily sludge	288.7	22.65	224.4	854.0	15.20	11.05	66.05	3.050
Poultry manure	206.9	16.822	46.7	328.0	2.75	1.94	0.01	0.002
Municipal solid waste	291.6	55.45	217.2	856.0	11.35	10.55	75.55	2.750
Mean	262.4	31.64	229.4	679.3	9.77	7.85	47.20	1.930

Table 2: Heavy metals content of oily sludge/Poultry manure compost during the composting process

Period of composting	Ratio of	Heavy metals (mg kg^{-1})							
(weeks)	mixture	Zn	Cu	Mn	Fe	V	Ni	Pb	Cd
	1:1	296.6	39.25	215.2	796.5	12.09	8.8	0.08	0.005
	1:5	278.8	22.80	320.28	67.5	7.12	6.8	0.07	0.002
2	1:10	274.3	14.55	396.08	69.4	6.85	5.4	0.05	0.002
	1:20	208.7	10.70	410.0	9.89.0	2.49	4.3	0.04	0.001
Mean		274.6	21.83	335.4	880.6	7.14	6.58	0.06	0.003
	1:1	282.9	30.41	332.3	856.5	8.51	11.8	0.007	0.003
4	1:5	282.4	29.05	247.58	67.6	8.48	10.7	0.005	0.001
	1:10	278.6	28.11	348.88	76.5	5.07	8.42	0.002	0.001
	1:20	266.7	17.85	362.1	897.0	4.98	7.05	0.001	0.001
Mean		277.6	26.363	22.78	74.5	6.76	9.50	0.004	0.002
	1:1	281.6	34.55	309.0	891.0	8.49	11.85	0.007	0.002
6	1:5	280.0	30.02	343.9	903.5	8.37	9.35	0.005	0.001
	1:10	274.7	19.75	370.3	867.0	6.44	9.31	0.002	0.001
	1:20	246.8	12.113	35.3	764.5	3.59	4.15	0.001	0.001
Mean		270.8	24.11	339.6	856.5	6.72	8.6	70.004	0.001
Grand mean		276.0	24.10	332.6	870.5	6.87	8.25	0.022	0.002

Table 3: Contents of heavy metals in the oily sludge and municipal solidwaste compost during the composting process

Period of composting	Ratio of	Heavy metals (mg kg^{-1})							
(weeks)	mixture	Zn	Cu	Mn	Fe	V	Ni	Pb	Cd
	1:1	297.6	51.4	229.0	857.5	12.2	20.4	146.0	5.07
	1:5	294.3	46.7	228.2	857.5	11.1	17.5	905.6	3.08
2	1:10	288.4	43.8	209.0	855.0	9.2	14.9	97.4	2.08
	1:20	283.7	39.4	166.5	854.0	7.2	13.6	79.3	2.00
Mean		291.0	45.3	208.2	856.3	10.0	17.1	107.1	3.06
	1:1	317.6	54.2	221.0	796.0	12.4	14.6	133.7	3.40
4	1:5	287.8	382	211.9	763.0	10.8	14.2	55.7	3.82
	1:10	283.8	35.7	208.9	741.5	10.2	12.2	45.8	3.64
	1:20	282.4	31.0	188.7	704.9	8.2	12.0	16.1	1.97
Mean		292.9	39.78	207.65	751.4	10.4	13.3	62.8	3.71
	1:1	294.7	70.1	286.3	835.0	7.0	11.3	98.0	7.01
6	1:5	292.6	42.9	245.3	854.0	3.9	10.7	66.1	2.75
	1:10	288.5	39.5	200.4	856.0	3.7	6.4	55.7	2.03
	1:20	269.6	35.4	146.9	859.0	2.9	4.5	24.5	1.02
Mean		286.4	46.97	219.7	851.0	4.4	8.2	61.1	3.20
Grand mean		289.9	44.03	212.5	819.6	8.27	12.9	77.0	3.32

(Ababio, 1997) especially in soils of the humid tropics. Such elements as Zn, Cu, Mn and Fe, which are known to be essential nutrients in soil and plant nutrition were found in all these wastes in relatively higher concentrations than the other heavy metals. This shows that improved and applied scientific treatment of this waste could serve as a good source of nutrients to the soil and growing plants. Trace content of Ni, V, Pb and Cd in these wastes is advantageous since they are not "essential" in plant nutrition and may be harmful to humans if available in high concentrations. However, the contents of the heavy metals are within international acceptable limits for soil application (Jones and Jarvis, 1981; Onah *et al.*, 1996).

Heavy metals contents of the prepared composts: Heavy metals content of Oily Sludge/Poultry Manure (OSPM) and Oily Sludge/Municipal Solid Waste (OSMW) composts during the composting process is presented on Table 2 and 3. The content of Mn and Fe in the Oily sludge/poultry other heavy metals (Zn, Cu, V, Ni, Pb and Cd) in this compost decreased with increased with increase in the proportion of the Pm in the composting ratio. This might be due to the high levels of Mn and Fe and low levels the other heavy metals in the fresh poultry manure as shown in Table 1. John *et al.* (2001) reported an average content of Fe (3320.8 $\mu g\ g^{-1}$) and Mn (166.7 $\mu g\ g^{-1}$) of municipal solid waste in three locations in Uyo municipality).

CONCLUSION

Composting of oily sludge with poultry manure or municipal solid waste as bulking agent provides a cost-effective and environment-friendly waste management alternative for the crude oil production sludge before final application to the soil. Low concentrations of heavy metals known exclusively to be major pollutants (Pb, Cd, Ni and V) in the resultant composts is an indication of the safety and hygienic level of these composts for direct application to the soil as a source of essential nutrients. Heavy metals content of fresh organic materials and the resultant composts fell within the internationally acceptable limit for soil and plants. These levels of plant nutrients would not pollute the soil on application, but will enhance improvements in soil fertility towards increased growth and yield of crops.

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