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Effect of palm oil mill effluent (POME) on an Arenic kandiustult in South Eastern Nigeria.

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Abstract

The study investigated the impact of long term application of palm oil waste on physical and chemical properties of a sandy Ultisols (Arenic Kandiustult) in Uga, Nigeria. Soil samples were collected from the surface (0-10cm) and (15-25cm) of palm oil polluted site. Another surface sample of (0-10) and (15-25) samples were collected 15 meters away in the palm oil unpolluted (control site). Core samples were collected from both soils. All the samples were analyzed for selected physical and chemical properties. The results showed that both soils were loamy sand but varied in the other physical properties as bulk density and total porosity. The two soils were strongly acidic, but had more carbon, nitrogen and phosphorus in the palm oil polluted soils than in the unpolluted soils. The results indicated that the area affected with the palm oil mill effluent (POME) had more nutrient status but reduced plant growth due to clogging of water and restricted aeration. The statistical package used to analyze this work is descriptive statistics and paired sample T-test. Knowledge of the component and proper disposition of these pollutants should be made known to the people of Uga.

Keywords: Keywords: Degradation; Palm oil mill effluent; Environmental hazards.
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Introduction

The process of extracting oil from palm oil fruits is carried out in mills. Large quantities of water are used during the extraction of crude palm oil from the fresh fruits and about 50% of the water results in palm oil mill effluents (POME). It is estimated that for 1 tonne of crude palm oil produced, 5-7.5 tonnes of water will end up as POME (Ahmed *et. al.*, 2003).

POME is the most polluted organic residue generated from palm oil. It is composed of high organic content. Untreated POME contains high concentration of free fatty acids, proteins and plant tissues but it is non toxic (Ngan *et. al.*, 1996). It has a high biological oxygen demand BOD which makes it more polluting than other domestic sewage (Okwute *et. al.*, 2007). This effluent is a serious land and aquatic pollutant when discharged immediately into the environment. Besides the presence of lipids and volatile compounds, the inhibitory effects of POME on living tissues, could also be due to presence of water-soluble phenolic compounds (Radzia 2001; Perez *et. al.*, 1992).

Palm oil mill effluents had been discovered by the people of Malaysia as better organic compost for agricultural production than chemical fertilizer after treatment to remove the oil in the effluent (APOC, 2004). However, it has been observed that most of the POME produced by the small scale traditional operators in Uga undergo no treatment and is discharged into the agricultural land that is used for arable farming (Umeugochukwu, 2010). This may have been responsible for the situation at Uga where no plant was found growing on the area where the effluents were disposed.

This study was designed to investigate the effect of POME on soil physical and chemical properties and suggest a better way of disposing the effluent to enhance food production and security.

Material and Methods

The area under investigation lies within longitude70^0 4'E and latitude 630 56'N. It is about 32km south of Awka, Anambra state capital. It is bounded to the East by (Awalasi Uga) and North east by (Oka) down to south by (Umueze) and southeast (Umuoru) Uga. The study area falls within humid tropical zone. The two major seasons in the area are wet and dry season with the former lasting for 8 months (April- October) and the latter for 4 months. (November-March). The average annual rainfall is 1485.2mm with mean annual temperature between 27^{0}C and 35^{0}C (Badiane, 2009). The relative humidity ranges from 40%-92%. The vegetation of the area is rain forest with mainly grassland and savannah vegetation. The dominant land uses are cereal and arable cropping systems. The soils were classified as ultisol (Arenic Kandiustult) bases on USDA soil classification system (Umeugochukwu, 2010).

Soil sampling method:

Soil sampling: Auger soil samples from the two sites (polluted and unpolluted) were collected from 0-15 and 15-25cm depth. Four core samples were taken before compositing.

For purposes of analysis, the surface samples were composited separately from the subsurface samples. Undisturbed core samples were collected from the surface (0-15cm) and subsurface (15-25cm) of palm oil polluted and unpolluted site. The unpolluted samples were collected 15 meters away from the palm oil polluted site and all were analyzed for selected physical and chemical properties.

Table 1. Selected physical properties of the polluted and unpolluted soils.

	Designation	Depth(cm)	%Clay	%Silt	%T.sand	F.S	C.S	B.D	T.P	T.C
Polluted soil	Top Polluted	0-10	10	8	82	48	36	1.2	54	Loamy
	Sub polluted	15-25	12	7	81	40	28	1.3	50	Sand
Unpolluted soil	Top unpolluted	0-10	11	1	88	44	36	1.4	47	loamy
	Sub unpolluted	15-25	14	2	84	40	32	1.5	43	Sand

Bulk Density, Total Porosity and Pore size distribution: The bulk density value obtained from polluted soil (1.2 g/cm^3) was lower than that of the unpolluted soil (1.4 g/cm^3). The bulk densities values averaged 1.2 g/cm^3, for the polluted soil and 1.45 g/cm^3 for the unpolluted soil. The total porosity averaged 54% for the polluted soil and 47% for the unpolluted soil. The mean bulk density of the polluted soil is lower than the mean bulk density of the unpolluted soil (Table 2). The polluted soil with lower bulk density recorded higher total porosity than the unpolluted soil with higher bulk density Table 1.

Chemical properties

The soil pH was generally low. It ranged from 4.8-4.9 H_20 for all the soils (Table 4). The mean values of the pH for the two soils were 4.8 for the polluted and 4.9 for the unpolluted (Table 3). The soils were extremely acidic. There was no significant difference in the pH of the two soils.

Table 2. Mean value and T value/ significant levels of soil physical properties of polluted and unpolluted soils in Uga.

Parameter	Mean	Std Dev	Std Error	M.D	T-Value
Clay P1	11.0	1.41	1.00	-1.50	-3.00
P2	12.50	2.12	1.50		
T. Sand P1	81.50	0.71	0.50	-4.50	-3.00
P2	86.00	2.83	2.83		
C.S P1	32.00	5.66	4.00	-2.00	-1.00
P2	34.00	2.83	2.00		
Silt P1	7.50	0.71	0.50	6.00	6.00
P2	1.50	0.71	0.50		
B.D P1	1.25	7.07	5.00		
P2	1.45	7.07	5.00		
T.P P1	52.00	2.83	2.00		
P2	45.00	2.83	2.00		

Legend: T. Sand= total sand, C.S = coarese sand, B.D= Bulk Density, T.P= Total porosity.

Table 3. Mean values and T - values/significant levels of soil chemical properties of polluted and unpolluted soils in Uga

Parameter		Mean	Std.	Std. Error	M.D.	T–value significant level
pH	P1	4.9	0.00	0.00		
	P2	4.8	0.00			
Carbon	P1	1.06	8.48	6.00	0.55	111.00
	P2	0.51	9.19	6.50		
Av.p	P1	62.00				
	P2	56.00				
Exch.Mg	P1	3.00	0.141	1.00	5.55	0.00
	P2	3.00	0.00	0.00		
Nitrogen	P1	0.07	0.11	0.05	0.00	0.00
	P2	0.07	0,23	0.11		
Org.M	P1	1.82	0.12	0.06	0.96	7.918
	P2	0.86	0.12	0.06		
Exch. Ca	P1	5.00	1.41	1.00	1.00	1.00
	P2	4.00	0.00	0.00		
Exch. Na	P1	0.015	0.005	0.002	0.005	1.732
	P2	0.010	0.000	0.000		
B.S	P1	73.50	10.97	5.48	16.50	3.362
	P2	57.00	20.70	10.39		

The mean value of soil organic matter (1.82%) was higher in the palm oil polluted soil than in the unpolluted soil (0.86%). The values increased with depth in the palm oil polluted soil and decreased with depth in the unpolluted soil. The topsoil of the palm oil polluted soil had 1.72% and 1.93% organic matter in the sub layer. The unpolluted soil had 0.97% in the topsoil and 0.76% in the subsurface (Table 4). The differences in mean was significant (P>0.05). The values of the polluted soil and the unpolluted soils were statistically different.

The two soils had high amounts of available phosphorus. The polluted had more P than the unpolluted soil. The mean values of the two soils were 62mg/kg and 56mg/kg for polluted and unpolluted soils respectively. There was no difference in the trend of distribution of phosphorus in the top soil and the sub soil of the polluted and unpolluted soils. There was no significant difference in the available phosphorus of the two soils.

Table 4 Selected Chemical properties of the Polluted and unpolluted soils

Depth (cm)	pH	C (g/kg)	O.M (g/kg)	N (g/kg)	Av.P (mg/kg)	Exchangeable bases (Cmol/kg)				C.E.C (Cmol/kg)		B.S (%)	Exch. Acidity (Cmol/kg)	
						Na^+	K^+	Ca^{2+}	Mg^+	ACEC	ECEC		Al^{3+}	H^+
					Polluted Soil									
0-10	4.9	1.12	1.72	0.08	62	0.02	0.06	0.6	0.4	1.3	2.66	83	0.2	0.1
15-25	4.9	1.00	1.93	0.06	62	0.01	0.03	0.4	0.2	1.0	1.94	64	0.2	0.1
					Unpolluted Soil									
0-10	4.8	0.57	0.97	0.09	56	0.01	0.04	0.4	0.3	1.05	2.10	75	0.2	0.1
15-25	4.8	0.44	0.76	0.05	56	0.01	0.03	0.4	0.3	1.9	2.94	39	0.2	0.1

The mean values of the ACEC and ECEC meaning C.E.C as indicated in the methodology was 1.15cmol/kg, 2.3cmol/kg in the polluted soil and 1.47 cmol/kg, 2.5 cmol/kg in the unpolluted soil respectively. The differences were not significant at P>0.05. The base saturation had mean value of 73% in the polluted soil and was higher than the mean values of the base saturation in the unpolluted soil (57%). There were differences in the exchangeable acidity values for both soils.

The mean values of Na^+, K^+, and Ca^{++} were higher in the polluted than in the unpolluted soils. For both soil (polluted and unpolluted soils) mean exchangeable Na was 0.15cmol/kg, 0.45cmol/kg of K, 0.5 cmol/kg of Ca, in polluted soil and 0.10cmol/kg of Na, 0.35cmol/kg of K, and 0.5 cmol/kg of Ca in the unpolluted soil. Mg had mean value of 0.3 in both soils.

Discussions

The relatively high sand content in the area is the reflections of the effect of the sandy parent material. The dominance of sand size particles would have emanated from the presence of such particles in the parent material of the soils. The parent materials of the soils of eastern Nigeria have been noted to influence the texture of the soils derived from them (Asadu and Agudosi,1994).

The relatively higher clay content in the subsurface layers in each site may have resulted from the process of elluviation from the upper horizons. The low clay content observed in the upper layers of these soils may further indicate the degree of weathering and leaching that the soil has undergone (Asadu *et. al*., 2008). The higher silt content observed in the upper layer of the polluted soils may be due to the effect of palm oil mill effluent. This can be attributed to reduced floatation of silt particles in runoff and hence reduced carting away of silt particles by overland flow. However the soils of these areas are inherently low in silt content (Akamigbo, 1984) essentially due to low content of these particles in the original parent material.

A test of mean difference carried out to compare the mean values of the particles size analysis data between the two soils, however showed that the mean clay, silt and sand contents were significantly different at P>0.05. Thus the palm oil mill effluent (POME) influenced the particle size distribution in the soil significantly. Salimon (2007) noted that the impact of POME on the physical properties of soil depends on the method of application. He noted that it can be used as organic fertilizer material to improve degraded sandy and low organic matter soils.

The lower bulk density in the palm oil polluted soil can be attributed to the accumulation of palm oil effluent in this soil. The bulk density value was lowest on top of the polluted soil showing that the effect is more at the zone of application. As you go down the sub layers, the effect reduced. Palm oil mill effluent contains a lot of organic materials of low bulk density (Harrison, 1995) and so impacts this property to the soil. There was increase in the values of the bulk density down the layers both in the polluted and the unpolluted soils.

Increase in total porosity is often correlated with decrease in bulk density. This was observed in the samples of the polluted and unpolluted soils where the mean total porosity was lower in the polluted soil than the unpolluted soil. The paired t-test showed significant difference in the samples from polluted and unpolluted soils. The mean t-test of porosity was significantly higher in the unpolluted soil than in the polluted soil at $P>0.05$.

It has been reported that when raw POME is discharged, the pH is acidic (Hemming, 1977) but seems to gradually increase to alkaline as biodegradation takes place. Soil acidity is one of the principal factors affecting nutrient availability, therefore availability of major nutrients (N,P,K) cannot effectively promote high yields of crops if soil pH is not correct. The uniformity in the soil pH indicated that the samples were collected from the same soil. The low pH noticed in the POME (Table 5, Zinatizadeh (2006) could be as a result of presence of phenolic acids and oxidation of the organic acid compounds (Nwoko, 2010).

Table 5: Typical characteristics of POME (Ma, 2000)

Parameter	Average	Metal	Average
pH	4.7	Phosphorus	180
Oil and Gas	4000	Potassium	2270
Biochemical Oxygen Demand(BOD)	25000	Magnesium	615
Chemical Oxygen Demand(COD)	50000	Calcium	435
Total Solids	40500	Boron	7.6
Suspended Solids	18000	Iron	46.5
Total Volatile Solids	34000	Manganese	2.0
Ammonical Nitrogen	35	Copper	0.85
Total Nitrogen	750	Zinc	2.3

All in mg/l except pH.

The higher values of organic matter in the polluted soil confirm the report of (Falodun *et. al.*, 2010). He observed that POME contains relatively high amount of plant nutrients. This may also be due the accumulation of the effluent on the soil. This is the reason POME can be used for growing crop and amending soil fertility depletion. Nwoko (2010) reported that POME amended plots gave higher maize height that significantly differed from that of control. Similarly, POME application with resultant positive yields may be attributed to the ability of the material to stimulate the decomposition of organic matter by introducing organism with high C degrading ability in the subsisting soil/plant environment.

The available phosphorus is more in the polluted soil than in the unpolluted soil. The palm oil mill effluent affected the availability of phosphorus in the polluted soil. The higher mean value of phosphorus in the polluted soil is in line with the work of Haun (1987) which suggested possibly high absorption in the soil or a possible precipitation of phosphate. He also said that there is good evidence that suggests that phosphorus is the dominant element controlling carbon and nitrogen immobilization. The uniformity in the pH reflected in the available P as acid soils tend to fix phosphorus.

According to Rhodes (1982) CEC usually expressed in meq/100g is a measure of quantity of readily exchangeable cations neutralizing negative charges in the soil. The high values of the CEC in the POME showed that its application enriched the plant medium with the exchangeable bases such as: Ca, Mg, Na, K and likewise N which is a constituent of the organic matter. Increase in CEC could be attributed to increase in pH dependent charges as well as addition of organic matter from the effluent as observed by Okwute (2007). The CEC and the exchangeable acidity were not different in the two soils but the base saturation showed significant difference at $p>0.05$ in the two soils. The base saturation average value of more than 50% suggests that the soil is fertile. The higher content of B.S in the polluted soil is an evidence of its higher fertility than the unpolluted soils.

Conclusion

The absence of vegetation in POME soil environment is attributable to soil's ability to retain water thus causing clogging of soil pores and hence water logging of the soil (Chan *et. al.*, 1980). Excess water in the soil restricts micro-organisms and their activities by preventing oxygen movement into and through the soil in sufficient quality to meet the oxygen demand of the organism.

From the result obtained in the study, it is obvious that the physical and chemical properties of the POME soils are different from that of the non POME. Since the POME has been shown to be acidic in nature, it is advisable for it to be treated before application to the soil Proper use of POME would lead to improved soil fertility and soil structure. Environmental pollution considered in small scale POME need better attention as these industries assumes greater importance.

References

Ahmed A, Ismail S, Bhatia S. (2003). Water recycling from **palm oil** mill effluent (POME) using membrane technology. *Desalination*, 157:87-95.

Ahn, P.M (1974). West African Soils, Oxford University Press, London.

Akamigbo, F.O.R (1984). The accuracy of field textures in a humid tropical environment.' Soil Survey and land Evaluation, Vol. 4

American Palm Oil Council (APOC), (2004). Sustainable palm oil practices, palm oil mill effluent (POME) and Empty Fruit Bunch Application as a nutrient Source in oil palm.

Asadu C.L.A, and Agudosi, H.C (1994). A comparative study of soils inside and outside ogbunike cave in Eastern Nigeria; Discovery and Innovation Vol.6 no 4. Pp367-371.

Asadu, C.L.A, Ucheonye-Oliobi, B. and Agada, C. (2008). Assessment of sewage application in south-eastern.Nigeria: Impact on soil morphological and physical properties, outlook on Agriculture Vol 37, No 1.Pp 63-69.

Badiane A. (2009). Executive Summary of Structure Plans For Awka, Onitsha And Nnewi And Environs 2009-2027. United Nations Human Settlements Programme publications can be obtained from un-habitat Regional Information Offices or directly from Nairobi Kenya. http://www.unhabitat.org/pmss/getElectronicVersion.asp?nr=2684&all

Bremmer, J.M and C.S. Mulvaney, (1982). Total N,P.895-926. In Page et al (eds) Methods of Soil Analysis. Part 2. 2nd ed. Agron. Monog. 9 ASA and SSSA, Madison WI.

Chan, K.W, Watson, I., Lim, K.C (1980). Use of Palm oil waste material for increased production. Paper presented at the Conference on Soil Science and agricultural development in Malaysia, Kuala Lumpur.

Falodun E.J, Osaigbovo A.U and Remison S.U. (2010). Effect of Palm oil mill Effluent and NPK15:15:15 fertilizer on the growth and yield of soya bean.

Gee, G.W and Bauder, J.W (1986). Particle size Analysis.P.383-411. In: Klute, A (ed). Methods of Soil Analysis part 2, 2nd ed Agronomy Monograph No 9,ASA and SSSA, Madison, WI.

Haun, K.C. (1987). Trials on long term effect of application of POME in soil properties, oil palm nutrition and yield. In; proceedings of the international oil palm, palm oil conferences (eds) 575-598.

Lal, R,and Greenland, D.J. (1977). Soil Physical properties and Crop Production in the tropics, John Wiley, New York, pp 7-9.

Mclean, E.O (1982). Soil pH and Lime Requirement. P. 199-224. In: Page et al (eds) Method of Soil Analysis part 2. Chemical and microbial properties. 2nd 288 ed. Agron. Monog. 9 ASA and SSSA, Madison WI.

Nelson, D.W., and Sommers, L.E (1982). Total Carbon, organic carbon and organic matter, in page, et al ed, method of soil Analysis, part 2, 2nd 291 ed Agronomy Monograph No 9,ASA and SSSA, Madison, WI, pp 539-579.

Ngan, M.A, Zajima, Y. Asahi M.,and Junit H (1996). A novel treatment process for palm oil mill effluent. PORIM TECHNOLOGY, October 1996.

Nwoko, C.O (2010). Evaluation of Palm oil mill effluent to maize (Zea mays. L) crop: yields, tissue nutrient content and residual soil chemical properties, Australian Journal of Crop Science.

Okwute, O.L and Isu, N.R (2007). Impact analysis of palm oil mill effluent in aerobic bacterial density and ammonium oxidizers in a dump site in Anyamgba, Kogi State. African Journal of Biotechnology Vol 6 (2) pp 116-119.

Olsen, S.R and Sommers, (1982). Phosphorus. P 403-434. In page et al (eds), method of soil Analysis, part 2, 2nd ed Agronomy Monograph No 9,ASA and SSSA, Madison, WI.

Perez J, de la Rubia T, Moreno J. and Martinez J (1992) Phenolic content and antibacterial activity of olive oil waste waters. Enviro. Toxicology Chem. 11: 489-495.

Radziah, O. (2001) Alleviation of Phytotoxicity of Raw POME by microorganism retrieved Sept, 2005, from www.agri.upm.edu.my/agrosearch/v3n2/irpa3.htm.

Rhodes, J.O. (1982). CEC in A.L page R.H Miller and D.R keeney (eds) methods of soil analysis, part 2, Chemical and microbial properties. Madison Wisconsin: pp 149-157.

Salimon, B.O, (2007). 'The effect of palm oil mill effluent (POME) on soil properties, growth , Nodulation and yield of cowpea (Vigna Unguiculata) in palm oil producing zone of Nigeria' paper presented at the annual meeting of the Soil and Water Conservation Society, Saddlebrook Resort, Tampa, Florida <Not Available>. 2010.0604 from http://www.allacademic.com/meta/p174308_index.html.

Smith, S. R, Hail, J. E, and Hadley, P. (1989). Composting Sewage sludge wastes in relation to their suitability for use as fertilizer material for vegetable crop production. International Symposium of Compost Recycling of wastes, 4-7 October, Athens.

Thomas, G.W. (1982). Exchangeable cations, Pp 159-165. In page et al (eds) Method of soil Analysis, part 2, 2nd ed Agronomy Monograph No 9,ASA and SSSA, Madison, WI.

Umeugochukwu, O.P and Akamigbo, F.O.R. (2010). Soil Degradation as a prelude to Land degradation and Environmental Reserves in Uga, Aguata L.G.A of Anambra State. Nigeria. Proceedings of the 44th annual conference of Agricultural Society of Nigeria, 'LAUTECH,ogbomosho, 2010' pp1390-1393.

Vomicil, J. A. (1965). Porosity, In Black, C.A ed, methods of Soil Analysis Part 1, Agronomy Monograph 9, ASA and SSSA, Madison, WI, pp 299-314.

Zinatizadeh, A.A (2006). Biological treatment of Palm Oil Mill Effluent using an up flow Anaerobic sludge fixed film (UASFF) Bioreactor. PhD thesis unpublished

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