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Research Article

The Aftereffects of Palm Oil Mill Effluents (POME) Discharge on Some Soil's Physical and Chemical Properties

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Abstract

Palm oil mill effluent (POME) is an important waste product of oil palm milling process. It contains relatively high amount of plant nutrients, which when released into the soil enhance soil fertility. However, effects of POME on the soils of an environment could be positive or negative, depending on its disposal and management methods. The effects of palm oil mill effluents from local (LOPM) and modern (MOPM) oil palm processing mills at Aare-Ekiti and Temidire-Ekiti, in Ekiti State were evaluated on some properties of nearby soils, in the year 2019. Surface soil samples were taken at 0 m, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, 70 m, 80 m and 100 m from production points at the two processing sites. Soil properties were improved by POME, indicating that POME could be helpful in soil enrichment. Results indicated that soils near palm oil milling sites, from 10 m and farther, from the exact milling point (0m), could be good for crop production, if the discharge of the effluent is properly managed. With proper management and attention, POME would positively impact our soils. Awareness on proper disposal and management of palm oil effluent (POME) is therefore necessary.

Keywords: *Palm oil mill effluent (POME), Soil enrichment, Crop production, Proper management, Necessary attention.*

Introduction

Oil palm production is one of the major agro businesses in Nigeria. Oil palm industry has been recognized for its contribution towards economic growth and rapid development (Izah and Ohimain, 2016). The industry has also contributed significantly to environmental pollution due to the production of huge quantity of by-products from oil palm extraction processes (Rupani. *et al.*, 2010). Crude palm oil contains fatty acid ester of glycerol commonly referred to as triacylglycerol which is one of the world's most important edible oil. The process of extracting the oil from the fruit involves boiling/steaming which sterilizes the fruit and softens the mesocarp, digestion, oil extraction, clarification and purification (Igwe and Onyegbado, 2007).

The oil palm mills generate many by-products and wastes besides the liquid waste that has a significant impact on the environment, if not properly dealt with. An important waste product of oil palm milling process is the palm oil mill effluent (POME) which is the copious, viscous, brownish liquid waste that emanates during the production of palm oil. Effluent water is defined as water discharged from industry which contains soluble materials that are injurious to the environment (Wu. *et al.*, 2009). Palm oil production is very water intensive; a tonne of palm oil may require almost five to seven tonnes of water and 50% of this water may end up as POME (Bala. *et al.*, 2014). POME is therefore the largest and most significant pollutant from oil mills (Ibegbulam-Njoku and Achi, 2014). Studies have shown that POME contains about 90-96% water, soil particles, 0.6-0.7% residual oils and 4-5% total and suspended biosolids. In addition, it is

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acidic (pH 4-5) with high temperature, non-toxic and high organic contents (COD 50,000 mg/L and BOD 25,000 mg/L and 4,000- 6,000 mg/L of oil and grease). It comes with a very unpleasant odour (Zakaria. *et al.,* 2002; Ahmad. *et al.,* 2003; Poh and Chong, 2009).

In Nigeria, palm oil is processed industrially and locally and in most cases, POME from these mills is discharged directly untreated on nearby agricultural lands or into surface water bodies. The indiscriminate disposal of POME in the producing parts of Nigeria had been for decades, but recently, their deleterious effects on the environment is becoming alarming and noticeable (Igwe and Onyegbado, 2007). Palm oil mill effluent (POME) forms an impervious coat of organic matter on the soil surface thereby creating an anaerobic condition (Keu, 2013). It has also been shown to negatively impact microbial groups such as total heterotrophic, phosphate solubilizing, nitrifying, lipolytic, cellulolytic, and palm oil degrading bacteria. Awotoye. *et al*. (2011) and Ohimain. *et al*. (2013) reported that POME can impact the levels of nitrate, zinc, BOD and COD of nearby soils and rivers and even air quality. More still, POME has been noted to alter the soils water holding capacity, organic carbon and total nitrogen. In addition, it contains high pollution indicators including oil and grease, chemical oxygen demand (COD) and biological oxygen demand (BOD). However, POME contains several nutrients including light nutrients (nitrogen, potassium, magnesium, phosphorous, sodium) and heavy nutrients/metals (zinc, copper, cadmium, chromium, iron etc) (Awotoye. *et al.,* 2011; Ohimain. *et al.,* 2013). It also contains arable groups of microorganisms including lipolytic bacteria, methanogens, hydrocarbon degrading bacteria and fungi (Ohimain. *et al.,* 2013). However, gradual biodegradation and mineralization of POME may lead to delay effect in releasing these nutrient elements in the soil (Ezemonye. *et al.,* 2007; Okwute and Isu, 2007). Eze. *et al.,* (2013) submitted that increase in soil pH due to POME further results in raising the content of soil available phosphorus. The solids in raw POME are good organic matter sources (Chan and Chooi, 1982) and this Organic matter plays an essential role in soil productivity. Several organisms invade and grow in POME, breaking down complicated molecules into simple ones (Okwute and Isu, 2007), thus biodegrading the POME enhances bioavailability of plant nutrient (Ohimain. *et al.,* 2012). The changes in the soil physical and chemical properties and other vital nutrients via POME discharge have the potential of affecting the soil texture and particulate size. POME discharged into the soil increases the soil bulk density and percentage of silt and clay. These and some more have been cited as probable advantages of POME over other effluents as it may be used to enhance soil fertility (Okwute and Isu, 2007). Other changes in soil compositions associated with POME have been reported by Woods (1979), Ovaisogie and Aghimien (2003) and Chinyere. *et al*., (2013). There have been trials of possible reuse of POME for other products (Masngut. *et al*., 2007; Wu. *et al*., 2009). Pasha (2007) formulated POME as food for animal and agricultural organisms. Various techniques have been applied to detoxify POME (Igwe and Onyegbado (2007). Also, Chinyere. *et al*. (2013) altered the pH of POME.

In the developed countries, stringent regulations by regulating agencies have resulted in the treatment of generated POME before their disposal into the environment (Najafpour. *et al*., 2006). However, in Nigeria, and Ekiti State in particular, there are no such strict regulations on POME disposal. As a result, POME generated from oil mills is usually disposed directly into the environment, mainly soils and also nearby aquatic habitats without any prior treatments which often pollute and adversely affects the environment. Therefore, there is need to bridge the knowledge gap on the resulting problems of this indiscriminate disposal of POME and to educate oil mills and concerned farmers on proper disposal, management and use of POME in Nigeria, like the developed countries. This study was therefore designed to evaluate some physical and chemical properties of soils in Aare and Ijurin Ekiti, as affected by direct deposition of POME and therefore, evaluate the effects of POME from local and modern oil palm processing methods on soil properties.

Materials and Methods

Study Sites

Two study sites were chosen in Ekiti State, a rainforest region in southwestern Nigeria. Ekiti State is an agrarian region where both arable and tree crops are being grown. Oil palm is one of the commonly grown tree crops, and fruits produced are processed into palm oil for human consumption and other uses. Aare-Ekiti is notable for local oil palm processing while in Temidire-Ekiti, both local and modern milling facilities for oil palm processing, are available.

Soil Sampling Preparation

Samples for this study were collected at Aare-Ekiti and Temidire-Ekiti oil palm processing mills, in April, 2019. A control sample each was taken from the two host communities; Aare and Temidire, and ten (10) samples were collected from each milling sites. The soil samples were taken at depth 0 - 15 cm, at distance 0, 10, 20, 30, 40, 50, 60, 70, 80 and 100 m respectively, away from the processing points. The soil samples were air-dried, crushed and sieved and prepared for analysis.

Laboratory Analytical Procedures for Soil Parameters

The laboratory analyses were done in the Soil Laboratory of the Department of Soil Resources and Environmental Management, Ekiti State University, Ado-Ekiti, Ekiti State, Nigeria. The particle size distribution was determined using the hydrometer method of particle size determination. The pH values of the soil samples were determined both in water and KCl. The organic matter content of the soil was determined using the Walkey-Black method (Nelson and Sommers, 1996). Total N was determined by the Kjeldahl digestion and distillation method. Available phosphorus was determined, using Bray P1 method. The exchangeable bases were determined using flame photometry method for Na and K, and atomic absorption spectrophotometry for Ca and Mg and the exchangeable acidity was extracted with 1 N KCl and determined by titration with 0.05 N NaOH using phenolphthalein indicator (Udo. *et al.*, 2010).

Results

Chemical Properties of the Impacted Soils at the Local Oil Palm Processing Mill in Aare-Ekiti

Table 1 shows the results of the chemical properties of the soils of Aare-Ekiti, including the samples from local oil palm processing mill (LOPM) site in Aare. Aare-Ekiti soil (the control soil) was slightly acidic in nature, having pH 6.68 (H_2O). The pH of the POME impacted soils ranged from 6.05-7.26 and 5.69-6.90 in water and KCl respectively. The average pH in Aare soil was 6.57 (H_2O) and 6.18 (KCl) indicating the soil is slightly acidic. The highest pH value was recorded at 10 m away from the point of POME discharge (0 m), where the least pH values were recorded.

The organic matter in the control soil was 2.09 g/kg while it ranged from 3.36-9.29 g/kg in the POME impacted soils, from LOPM site, with an average value of 5.95 g/kg; an indication that the POME from local oil palm processing method improved the soil organic matter above 2.09 g/kg. The organic matter initially increased with sampling distance up to 30 m point and later declined with distance.

Soils in Aare-Ekiti were generally sufficient in available P as the Control soil recorded 16.50 mg/kg. Available P in POME impacted soils in Aare ranged from 30.50-100.75 mg/kg P with an average of 65.45 mg/kg P. The 30 m sampling point had the highest available P value which then decreased with sampling distance.

The exchangeable Ca recorded was highest (5.68 cmol/kg) at 70 m sampling point with 60 m having the least value of 1.46 cmol/kg with an overall average of 3.12 cmol/kg.

Table 1: Chemical properties of POME impacted soils at local oil processing mill (LOPM) in Aare-Ekiti

Sample	**pH**		**Org. M**	**Tot. N**	**Av. P**	**Ca**	**Mg**	**K**	**Na**	**Ex. A**
	(H_2O)	**(KCl)**	**(g/kg)**	**(g/kg)**	**(mg/kg)**	**(cmol/kg)**				
Control	6.68	5.68	2.09	1.2	16.50	2.94	1.10	1.90	0.80	0.24
0 m	6.05	5.69	5.56	2.5	99.00	1.90	3.77	2.23	1.15	0.28
10 m	7.26	6.90	5.91	2.7	80.00	3.75	1.51	3.10	1.20	0.24
20 m	6.07	6.03	9.29	4.5	51.75	3.16	1.50	2.87	1.15	0.36
30 m	6.67	6.50	9.29	4.6	100.75	3.10	1.86	3.04	1.17	0.40
40 m	7.12	6.55	6.99	3.0	94.50	2.53	1.47	2.89	1.11	0.24
50 m	7.06	6.84	5.44	2.0	81.00	5.25	1.34	2.37	1.07	0.24
60 m	6.37	5.81	4.07	1.6	41.00	1.46	0.93	3.05	1.16	0.20
70 m	6.61	5.82	3.87	1.5	30.50	5.68	1.45	2.25	0.98	0.16
80 m	6.32	5.80	5.68	2.5	43.50	1.63	1.18	3.08	0.94	0.24
100 m	6.18	5.81	3.36	1.3	32.50	2.75	1.99	2.01	0.90	0.20
Mean	6.57	6.18	5.95	2.5	65.45	3.12	1.70	2.69	1.08	0.26

OM = Organic matter, Tot. N = Total nitrogen, Av. P = Available phosphorus, Ex. A = Exchangeable acidity.

The Ca content in the soils at LOMP in Aare-Ekiti at 0 m was lower than the average value of 3.12 cmol/kg. Ca contents for the various distances from the milling point did not follow a definite pattern. Values of exchangeable Mg in locally produced POME impacted soils in Aare were rated medium except at 60 m (0.93 cmol/kg) which rated low. The result showed that POME increased the Mg content of the soil having a mean of 1.70 cmol/kg compared to 1.1 cmol/kg which was recorded in the control soil. The Mg values recorded for the various sampling points did not also follow a specific trend. Though the exchangeable K showed an inconsistent pattern of distribution with sampling distances, it was still rated very high in the soils as influenced by locally produced POME, ranging from 1.9 cmol/kg in the control soil to 3.08 cmol/kg at 80 m sampling point in POME affected soils. Exchangeable Na decreased with sampling distance away from the POME discharge point (0 m). The control soil recorded the least value of 0.80 cmol/kg and values ranged from 0.90-1.17 cmol/kg in locally produced POME affected soils with an average of 1.08 cmol/kg. The exchangeable Na was rated high in Aare-Ekiti soil. Means of the exchangeable cations were higher in the POME impacted soils compared to the control soil.

The exchangeable acidity ranged from 0.16 cmol/kg, recorded at 70 m sampling point to 0.40 cmol/kg, recorded at 30 m sampling point. On the average, POME affected soils in Aare-Ekiti had higher exchangeable acidity (0.26 cmol/kg) than the control soil (0.24 cmol/kg), an indication that POME from local oil palm processing method contribute to soil exchangeable acidity.

Particle distributions of the impacted soils at the Local Oil Palm Processing Mill in Aare-Ekiti

The particle size distributions of the soils in LOPM in Aare were presented in Table 2. The impacted soils of Aare recorded an average of 833.0 g/kg, 116.8 g/kg and 50.2 g/kg of sand, silt and clay respectively. Only the impacted soils at sampling point of 10 m from the milling point were sandy; others were either loamy sands or sandy loam. The soils at 40, 70, 80 and 100 m away from the milling point were sandy loam, with the highest percent silt of 170.8 g/kg recorded from 80 and 100 m distances away from the milling point.

Chemical Properties of the Impacted Soils at the Modern Oil Palm Processing Mill in Temidire-Ekiti

Table 3 shows the results of the chemical properties of the soil in modern oil palm processing mill site in Temidire-Ekiti. The highest pH both in water (6.93) and Kcl (6.51) was recorded at 0 m sampling point. The pH thereafter decreases and the least value in water (5.85) was recorded at 60 m and 80 m while the least value in Kcl (5.01) was recorded at 60 m sampling point.

The organic matter content of soils at the modern oil palm processing mill in Temidire-Ekiti was moderate having an average of 5.20 g/kg. The organic matter generally decreased with distance from the point of POME discharge (0 m with 12.80 g/kg). The total nitrogen ranged from 0.9 (100 m) to 6.1 (0 m) g/kg in POME impacted soils at MOPM. Total nitrogen could be considered to be moderately good for crop production at all points in the POME impacted soils of Temidire-Ekiti, except at 100 m sampling point.

Table 2: Physical properties of POME impacted soils at local oil palm processing mill (LOPM) in Aare-Ekiti

Sample	Sand	Silt	Clay	Textural class
	(g/kg)			
Control	852.0	110.8	37.2	Loamy sand
0 m	832.0	110.8	57.2	Loamy sand
10 m	912.0	60.8	27.2	Sandy
20 m	892.0	80.8	27.2	Loamy sand
30 m	892.0	80.8	27.2	Loamy sand
40 m	772.0	160.8	67.2	Sandy loam
50 m	822.0	130.8	47.2	Loamy sand
60 m	892.0	60.8	47.2	Loamy sand
70 m	762.0	140.8	97.2	Sandy loam
80 m	782.0	170.8	47.2	Sandy loam
100 m	772.0	170.8	57.2	Sandy loam
Mean	833.0	116.8	50.2	Loamy sand

Table 3: Chemical properties of POME impacted soils of modern oil palm processing mill (MOPM) in Temidire-Ekiti

Sample	pH		O.M	Tot. N	Av. P	Ca	Mg	K	Na	Ex. A
	(H_2O)	(KCl)	(g/kg)	(g/kg)	(mg/kg)		(cmol/kg)			
Control	6.35	5.25	2.04	1.2	14.40	2.60	0.8	1.60	0.60	0.76
0 m	6.93	6.51	12.80	6.08	87.50	4.93	0.8	2.08	0.80	0.96
10 m	6.54	5.83	6.10	3.20	83.50	4.46	1.36	0.90	0.74	0.86
20 m	6.37	5.40	3.40	13.30	43.50	3.27	0.74	0.80	0.73	0.48
30 m	6.63	6.08	5.34	24.00	58.50	3.37	0.89	0.96	0.74	0.48
40 m	6.51	5.74	5.34	12.60	62.00	2.47	1.43	1.12	0.75	0.64
50 m	6.34	5.58	6.75	38.60	75.70	2.46	1.45	1.00	0.74	0.72
60 m	5.85	5.01	5.15	12.00	61.50	2.48	0.73	0.78	0.72	0.72
70 m	5.91	5.09	2.10	10.00	30.00	1.73	0.54	0.80	0.73	0.64
80 m	5.85	5.28	2.20	11.60	39.00	1.61	0.63	0.80	0.73	0.96
100 m	6.08	5.41	2.72	0.90	31.50	1.78	0.61	0.86	0.74	0.56

Mean	6.30	5.59	5.20	13.23	57.27	2.86	0.92	1.01	0.74	0.70

Org. C = Organic carbon, OM = Organic matter, Tot. N = Total nitrogen, Av. P = Available phosphorus, Ex. A = Exchangeable acidity.

The available P in the soils of MOPM site in Temidire-Ekiti was generally higher than the Bray P1 (8 mg/kg) critical P level stipulated for soil in Nigeria. The available P ranged from 30 mg/kg P at 70 m to 87.50 mg/kg at 0 m. The P values did not follow a particular trend of distribution, though 70-100 m sampling points recorded least values.

Like in Aare-Ekiti impacted soils, the exchangeable Ca decreased with distance, in some instances but not generally, meaning that no exact pattern could be emphasized. The exchangeable Mg rated low in the POME affected soils in MOPM at Temidire-Ekiti with the 0 m sampling point having the least value of 0.80 cmol/kg and 50 m having the highest value of 1.45 cmol/kg. The exchangeable Mg also exhibited decreasing distribution pattern along the sampling distance, similar but lower in values to the pattern observed in soils around the LOPM at Aare-Ekiti. The exchangeable K ranged from 0.78-2.08 cmol/kg at 60 m and 20 m sampling distance respectively. On the average, the Temidire-Ekiti soil was rated high in exchangeable K. The exchangeable K, though decreased with sampling distance, a specific pattern was not experienced, like in LOPM site. However, Temidire-Ekiti soils, impacted by POME from MOPM had lower exchangeable K content compared to Aare-Ekiti soils impacted with POME from LOPM. The exchangeable Na of Temidire-Ekiti soils with an average Na content of 0.74 cmol/kg rated high. It ranged from 0.72 (60 m) to 0.80 (0 m) cmol/kg. The exchangeable Na had a distribution trend similar to that of exchangeable K and also generally lower than values recorded in Aare soils impacted by locally produced POME.

The exchangeable acidity ranged from 0.48-0.96 cmol/kg with the point of POME discharge having the highest value. Soils in MOPM site in Temidire-Ekiti recorded an average of 0.70 cmol/kg exchangeable acidity which was more than 100% higher than the average of 0.26 cmol/kg recorded in soil in LOPM site in Aare-Ekiti. The 0 m recorded the highest value compared to other sampling points and initially decreased with distance up to 30 m.

Physical properties of the impacted soils at the Modern Oil Palm Processing Mill Site in Temidire-Ekiti

The physical properties of the soil in modern oil palm processing mill (MOPM) site in Temidire-Ekiti were presented in table 4. On the average, sand content was 718.0 g/kg, silt content was 91.0 g/kg and clay was 186.0 g/kg, indicating that soils in MOPM site in Temidire-Ekiti were sandy loam in texture. Unlike the particle distribution of soil in LOPM site in Aare, the sand and silt contents decreased with distance (though least silt content of 2.0 g/kg was recorded at 0 m) while clay content increased as one moves away from the point of discharge (0 m).

Discussion

Soil is a potent system of the terrestrial ecosystem. Direct and indiscriminate discharge of POME may have a profound influence on the physical and chemical properties of the soil. The effects of POME vary with the quality of the raw material and method of processing the oil palm. Studies have shown that physical and chemical properties of POME and even soil vary from location to location (Eze. *et al.*, 2013; Iwara. *et al.*, 2014).

In this study, the average pH of POME impacted soils in Aare was 6.57 (H_2O) and 6.18 (KCl) indicating the soils were slightly acidic (pH-H_2O) (FAO, 2008). The control soil was also slightly acidic in nature, having pH 6.68 (H_2O). Iwara. *et al.,* (2014) had earlier reported POME affected soils in Calabar to be near neutral in pH which was actually higher than the pH of a non- impacted soil. The highest pH recorded for Temidire-Ekiti impacted soils at the 0 m could possibly be attributed to the organic matter rich solids (Chan and Chooi, 1982) of the freshly discharged POME which usually gets cured as it moves further into other sampling distance.

Table 4: Physical properties of POME impacted soils of modern oil palm processing mill (MOPM) in Temidire-Ekiti

Sample	Sand	Silt	Clay	Textural class
		(g/kg)		
0 m	920.0	2.0	78.0	Sandy
10 m	760.0	112.0	128.0	Sandy loam
20 m	720.0	122.0	158.0	Sandy loam
30 m	780.0	102.0	118.0	Loamy sand
40 m	720.0	102.0	178.0	Sandy loam
50 m	740.0	142.0	118.0	Sandy loam
60 m	710.0	122.0	168.0	Sandy loam
70 m	640.0	72.0	288.0	Sandy clay loam
80 m	650.0	72.0	278.0	Sandy clay loam
100 m	540.0	62.0	348.0	Sandy clay
Mean	718.0	91.0	186.0	Sandy loam

Nitrogen contents at almost all sampling points of POME impacted soils in Aare and Temidire mills were above the critical level of 1.5 g/kg (Udo. *et al.,* 2010), indicating a good impact of POME on soil N.

The available P content of Aare-Ekiti soils (16.50 mg/kg) was 100% higher than the 8 mg/kg P stipulated as the Bray P1 critical soil P level in Nigeria (Chude. *et al.*, 2011). Bioavailability (Ohimain. *et al.,* 2012) of P could be said to be highest at 30 m distance away from the production point.

The higher organic matter recorded at sampling points near the 0 m, especially at the MOPM in Temidire-Ekiti, could be attributed to the biosolids waste generated from oil palm processing activities. The solids in raw POME had been reported to be good organic matter sources (Chan and Chooi, 1982) which plays an essential role in soil productivity. Several organisms invade and grow in the freshly deposited POME, which help in breaking down complicated molecules into simple ones (Okwute and Isu, 2007). The biodegrading reportedly enhance bioavailability of plant nutrient, including organic matter (Ohimain. *et al.,* 2012).

It was observed that Ca was generally low (FAO, 2006) in Aare and Temidire-Ekiti soils, though both the local and modern methods of POME production raised the Ca levels in the control soils of the sites. However, the exchangeable bases in the impacted soils of the local processing mill at Aare-Ekiti had reasonably higher values than the control soil of Aare-Ekiti (Okwute and Isu (2007). The exchangeable bases in the impacted soils of the local processing mill at Aare-Ekiti were not so poorly rated (FAO, 2006), and the exchangeable acidity values recorded in the soils samples were lower, or similar to the natural Aare soil, except at 0, 20 and 30 m distances where the exchangeable acidity values were higher than the control value. However, the soils closer to the milling point had higher values of exchangeable bases, in the MOPM site at Temidire-Ekiti. Exchangeable acidity values were higher in the impacted soils at the MOPM than the impacted soils at the LOPM. Higher exchangeable acidity values recorded for soils at MOPM site in Temidire-Ekiti could be an indication that POME disposal from MOPM contributes more to soil exchangeable acidity than that from LOPM.

The higher values obtained at the milling point (0 m), for nearly all variables measured, at the MOPM in Temidire might be due to the fact that, POME disposal at the MOPM is through a form of constructed drainage, whereas, at the LOPM, the produced POME are discharged and piled in heaps. Few splashes of the discharged POME, from the drainage, at the MOPM eventually impact the nearby soils, and the impacts are likely to get reduced with distances away from the milling point. However, POME deposited in heaps at the LOPM gets easily washed at every downpour, to impact the soils of the particular area.

The increase in the silt content of soils at farther distances around the local oil processing mill is in line with the report of Nnaji. *et al.*, (2016) and this could be attributed to the decrease in deposition of solids from the effluent onto the soils. Though, both the control soil and the POME impacted soils in Aare were of loamy sand/sandy loam textural class, the effects of POME deposition could be noticed on the increase in silt contents of the soils and as some soils from the site were tagged sandy loam. In the other hand, soils closer to the milling point at the MOPM had higher silt values. This could be explained by the report of Nnaji. *et al.*, (2016), as lower quantity of solids from the effluent got into the nearby soils of MOPM, due to the drainage pattern, unlike at LOPM, where POME is discharged on heaps. More impacts of the discharged POME were observed on the soils' texture at the MOPM site, as more textural classes; sandy loam, loamy sand, sandy clay loam and sandy clay were observed at the site. The discharged POME did not affect the soil textural class negatively (Okwute and Isu, 2007).

There was an enrichment of soils with regards to phosphorous, nitrogen, calcium, magnesium, sodium, and potassium at the two palm oil processing sites, especially the local oil processing mill at Aare-Ekiti. This indicated that proper use and safe disposal of POME in the land aided environment sustainability. These findings were in line with the findings of Oviasogie and Aghimien, 2003 who through their work confirmed that a proper use and safe disposal of POME in the land aids environment sustainability. Their results confirmed an enrichment of soils with regards to phosphorous, nitrogen, calcium, magnesium, sodium, and potassium following the application of the POME. Reduction of nutrients at some sampling points (distances) along the sampling areas in this study, did not actually mean that nutrients would not be made available to crops if planted at these points/distances, or near them, but that there might be delay effects in releasing the nutrients due to gradual biodegradation and mineralization of POME (Ezemonye. *et al*., 2007; Okwute and Isu, 2007).

Values of parameters measured at both sites indicated that soils near palm oil milling sites, from 10 m and farther, from the exact milling point (0 m), could still be good for crop production, if the discharge of the particular effluent is properly managed. It also indicated that POME could be helpful in soil enrichment, if properly managed. Thus, while essential products like palm oil is being obtained from oil palm milling, palm oil mill effluent (POME) discharge, could also be beneficial if given the necessary and proper attention. The government should create awareness to those involved in small and large scale palm oil processing on the need for proper disposal and management of palm oil effluent (POME) to sustainably improve soil properties rather than adversely affecting the soil fertility, if not properly managed.

Conclusion

Experiment was conducted to investigate the consequences/aftereffects of raw palm oil mill effluent discharge from two sites; local oil palm mill at Aare-Ekiti and modern oil palm mill at Temidire-Ekiti on some properties of nearby soils. Soil samples from 0 m, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, 70 m, 80 m and 100 m from production/milling points at the two processing sites were chemically analysed. The result showed an improvement in the properties of soils from the two milling sites, an indication that, POME could be helpful in soil enrichment. Soils around palm oil milling sites, as from 10 m and farther, from the exact milling point (0m), rather being abandoned, could be good for crop production. Palm oil mill effluent (POME) discharge should be properly managed, and proper awareness given to farmers and other necessary stakeholders, on proper disposal and management of palm oil effluent (POME), as POME would positively impact our soils and be a good soil additive, if properly discharged and managed.

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