International Research Journal of Environmental Sciences ISSN 2319–1414
Vol. **7(12),** 36-39, December **(2018)** *Int. Res. J. Environmental Sci.*

Mycological study of soil contaminated with effluents from palm oil mill in Anyigba, Kogi State

Emurotu, Marvelous Olubunmi*
Microbiology Department, Kogi State University, Anyigba, Kogi State, Nigeria
bunmi_emurotu@yahoo.com

Available online at: www.isca.in, www.isca.me
Received 31st August 2018, revised 6th December 2018, accepted 21st December 2018

Abstract

Investigations were carried out on mycological and physiochemical features of soil that is being contaminated with effluents from palm oil mill in Anyigba. Soil samples were taken out of four different locations and were analysed for total fungal count and soil physiochemical parameters for fourteen (14) days. The fungal count range from $8.0\ x10^6$ to $1.0x10^7$ cfu/g for palm oil mill effluent polluted soil (POME) (also known as effluents from palm oil mill (EFPOM)) and $2.0x10^4$ and $3.0x10^4$ cfu/g for free soil which served as the control (ofs). The pH, organic matter% as well as organic carbon%, nitrate, moisture contents% alongside phosphorus (ppm) analysed were found to be more in effluent contaminated soil (ECS) compared to the No-oil soil (NOS). Higher fungal count was recorded in the POME polluted soil when compared with oil free soil. The fungi isolated from the EPS were Aspergilus species, Fusarium species, Penicillium species, Geotrichum species, Trichoderma species and yeast. This work shows that the physico-chemical properties of soil contaminated with effluents from palm oil mill were altered by the effluents. The pH, organic matter, organic carbon, nitrate, moisture content and phosphorus content were more in ECS compared to NOS. This work shows further that the fungal counts in ECS was higher than NOS. This implies that fungi strive well in effluents from palm oil mill (EFPOM) and could efficiently use (EFPOM) as its food substrate. Therefore, fungi could be employed as a means of biodegrading and bioremediating soil contaminated with effluents from palm oil mill.

Keywords: Mycological, physicochemical, effluents, palm oil.

Introduction

When you talk about productivity, efficiency and land utilization, one of the world's most important, yielding plants is the oil palm mill (*Elaeis guineensis*). Available records have it that it produces about 4 to 5 tonnes of oil per hectare per year[1]. Oil from palm fruits is highly marketed edible oil in this generation. It is obtained from the flesh of the fruit (mesocarp). Apiece of the fruit comprises of the outer fleshy cover called mesocarp (reddish pulp), inside the mesocarp is an endocarp also known as shell, and a hard kernel (seed). At ambient temperature, palm oil is semi-solid due to its saturation level of about 50%. It is reddish in colour naturally because it contains large quantities of beta-carotene. Oil from palm also has monosaturated oleic acid 40%, palmitic acid 45%, polysaturated linoleic acid 10% (an essential fatty acid), and Stearic acid 5%[2].

It is shown from literature that the organic waste application (for example, effluent, sewage sludge and compost) to soils makes the plant growth to increase. Considerable amounts of plant nutrients including micronutrients are present in organic wastes which may be beneficial to the growth of plant[3]. Since effluent from palm oil mill (EFPOM) or palm oil mill effluent (POME) is organic in nature, it may as well serve as a major source or have great consequence on the supply of elemental nutrient to the soil. The feature of effluent from palm oil mill depends on the raw material's quality and production of palm oil processes in oil palm mills[2]. The biodegradation processes in POME is therefore of great interest to many researchers[4] because it generates high level of organic matter which is an indication of high biochemical oxygen demand (BOD) values in addition to the fact that it highly contains oil and grease which serve as major substrates for microorganisms[5].

Observations have shown that majority of the POME are not properly treated before they are being discharged into the soil especially by the those who do palm oil business on a small scale, thereby contaminating the soil with the effluents[3] and from runoff during rainy season to water bodies which may eventually lead to eutrophication of water bodies.

Production of Oil palm is one of the main socio- economic occupations of inhabitants of Anyigba, Kogi East, Nigeria. There is relative abundance of palm trees, consequently, large amounts of fruit from palm are reaped and worked on weekly. Large amounts of effluents from palm oil are released into the environment during processing. For decades, this has been the practice of the people but the people know nothing or little of the negative effect this effluent or waste possess on their soil. Oil in POME has been reported as an excellent source of carbon showing about twice the energy value of glucose during microbial growth[1]. Therefore, the degradative potential of fungi in biodegradation of POME is potentially seen to provide an alternative to clean up environmental pollution and have drawn interest in researches in the past two decades. This interest is base on the fact that most biodegradation researches focus mainly on the use of bacteria. The major interesting feature of fungi associated to bioremediation of POME is their potential to produce enzymes that essentially use lignin breakdown as well as ability to degrade various types of recalcitrant pollutants[6].

There is paucity of data on the mycological study of POME on soils in Anyigba a major food producing town and also depends on stream water for drinking and recreation. This work is done in order to determine the mycological and physiochemical features of soil contaminated with effluents from palm oil mill in Anyigba, Kogi State.

Materials and methods

Study area: The area where this study was carried out is known as Anyigba, in Dekina Local Government, Eastern Part of Kogi State. It lies between latitude $70^{0}361^{1}$ North of the Equator and longitude 70^{0} 121^{1} East of the Greenwich Meridian. Palm oil mill has become major activity of its inhabitants because of the abundance oil palm plantation in this area.

Sample collection: Soil samples were taken out of four different locations: that is, about 1.5metre prior to the effluent from palm oil mill dump site labeled as (A); the dump site, labeled as (B); about 1.5metre after the dump site, labelled (C) altogether, A,B and C are called effluent contaminated soil (ECS); and a no-oil soil sample gotten from about 20 metres away from site C and has no history of palm oil effluent previously dumped on it, labelled (D). D served as control and called No-oil soil (NOS). Sample collection was done according to the method described by Wollum[7]. Soil samples taken were then put into a polythene bags with labels, and were transported to the laboratory immediately to be analysed, where it was dried, ground then sieve by a 2mm sieve.

Sample analyses: Microbiological analysis: Analyses were carried out on the soil samples microbiologically for fungi count only and the total cell count was carried out using Potato Dextrose Agar (PDA).

Inoculation of samples: The soil sample was inoculated with 10^4 and 10^6 dilution on sterile PDA then incubated at ambient temperature for 72 hours.

Enumeration of fungi: Enumeration of fungi was performed. The isolates streaked on plates containing Potato dextrose agar and the colonies formed counted.

Characterization and identification of fungi isolates: Fungi isolates that grew on culture plates were characterized and identified based on cultural characteristics, morphological characteristics, and gram staining (yeast). The total number of colony were counted and recorded. All this was done according to the methods of Barnet and Hunter[8,9].

Physiochemical properties: The soil's physiochemical parameters determined were pH, nitrate, organic matter and carbon content, phosphorus alongside moisture content.

The pH of the soil samples were measured by the method described by Brady and Weil[10].

Moisture contents: Moisture contents performed by the method described by Agbenin[11].

Organic matter and carbon contents: Done by the Kalembasa and Jenkinson[12] method.

Nitrate content: Done by the Kjeldahl method as described by [13]Bremner and Mulvaney.

Available phosphorus in the soil performed by following the methods of I.I.T.A., Nelson and Sommers[14,15]. Organic matter and carbon contents done by following Jackson's method as described by Jackson M.L.[16].

Results and discussion

Result of physiochemical properties of soil analyzed: The physicochemical parameters results are given (Table-1). pH ranged from 5.60-5.80 in NOS and 6.90-7.90 in ECS. The organic carbon ranged from 1.20-1.26 % for NOS and 2.00 - 2.80 in EPS. The organic matter is a function of the organic carbon. The organic matter was higher in the ECS compared to NOS. It ranged from 3.46–4.84% in ECS and ranged from 2.08 to 2.18 in OFS. These values are lower than organic matter value of 6.60–17.5% reported for agricultural soil in Kogi State farmland as reported by Emurotu and Onianwa[17].

Table-1: Result of physiochemical properties of soil analyzed.

Parameters	ECS (days)		NOS (days) control	
	7	14	7	14
Ph	7.90	6.90	5.80	5.60
Organic carbon (%)	2.00	2.80	1.26	1.20
Organic Matter (%)	3.46	4.84	2.18	2.08
Nitrate	0.086	0.084	0.062	0.059
Moisture content (%)	18.30	19.10	7.00	6.82
Phosphorus (ppm)	16.36	16.68	12.00	11.80

ECS: Effluent contaminated soil, NOS: No-Oil soil.

The nitrate concentration in ECS was slightly higher than that of NOS. The level in ECS ranged from 0.084-0.086 while corresponding level in NOS ranged from 0.059-0.062. The phosphorus concentration ranged from 16.36-16.18 in ECS while in NOS values ranged from 11.80-12.00. The nitrate and phosphorus level in both soils are high and can support agriculture. However, this can be a major environmental pollution to adjourning streams on the amount of nitrate and phosphate in the soils. During rainy season there may be much runoff to the streams and consequently causes nutrients load on the streams. The observed moisture content in ECS was significantly higher compared to NOS. The NOS values ranged from 6.82-7.00 while observed ECS values ranged from 18.30-19.10.

Microbial analysis: The results of the microbial analysis are shown in Tables-2 and 3. The fungi counts of the effluent polluted sites (E), after the polluted site (A) and before the polluted site (B) and non contaminated soil site(C) are shown in Table-2. The fungal count ranged from E = 8.0 $x10^6$ to $1.0x10^7$ cfu/g, A = $6.0x10^6$ to $7.0x10^6$ cfu/g, B = $4.0x10^4$ to $5.0x10^4$ cfg/g, C = $2.0x10^4$ to $3.0x10^4$ cfu/g.

The morphological characteristics of fungi isolates obtained from the EPS in the course of this study are shown in Table-3. They are *Penicillium sp*, *Trichoderma* sp, *Aspergillus sp*, *Fusarium* sp, *Geotrichum* and yeasts.

Table-2: Colony count after 72 hours of incubation.

Weeks	Soil samples			
	E	A	B	C
1	8.0×10^6	6.0×10^6	4.0×10^4	2.0×10^4
2	1.0×10^7	7.0×10^6	5.0×10^4	3.0×10^4

E= effluent site, A= after effluent, B=before effluent, C= control.

Discussion: This study has shown that there is increase in the fungi counts of the soil contaminated with palm oil mill effluent than the non contaminated soil which served as the control. This increase may not be unconnected with the higher organic matter and carbon contents, moisture content, nitrogen alongside phosphorus in the POME polluted soil[18]. The most predominantly POME utilizing fungi identified includes genera *Aspergillus*, *Penicillium*, *Fusarium*, *Trichoderma*, *Geotrichum*, and Yeasts. This is in concord with the researches of Okwute[19]. Wong *et al.*[18] in their study also reported that *Aspergillus sp*. particularly are very efficient in producing cellulases, these enzymes help in cellulose breakdown in the effluents. There was an increase in the pH of the soil samples. Effluent polluted soil has the highest pH compared to the control.

The organic matter and carbon content were higher in effluent contaminated soils than the No-oil soils samples. POME or EFPOM decompose/decay and generate more carbon and organic matter in soil. Carbon and organic matter are utilized by degrading fungi for their growth. Carbon also serves as source of nutrients for the organisms and also required for degradation. This observation was in line with[20] who had similar result. Nitrate concentration was more in effluent contaminated soil (ECS) than the No-oil soil (NOS). The reason is because slightly increased organic matter content noticed in EPS than in NOS. Okwute and Isu[20] reported similar result and attributed the increase to the discharge of effluent into soil which adds to the levels of exchangeable bases. The increase in pH to near neutrality in POME soil has also been reported, when effluent from palm oil mill is being discharged into soil, the pH is acidic initially but gradually increase to alkaline as biodegradation takes place. Therefore, it implies that POME increases soil pH which in effect increases major nutrients (nitrates, potassium alongside phosphorus) in soil. Increase in soil pH from acidic to neutral was also reported by Atu et.al.[21] as a result of poultry manure treatment in eastern Nigeria soils.

Table-3: Morphological characteristics of fungi isolates from soil samples analyzed.

Isolates	Cultural description	Microscopic appearance	Sports	Suspected
A1	A creamy to brownish- black mycelium with dark sports and often appears golden on the reverse side	Presence of septae hyphae, long and smooth conidiophores, long unbranched sporangiophores	Sporulation	*Aspergillus species*
A2	A creamy yellowish powdering substance that appears yellow on the reverse side	Presence of dark pigment of micro and macro conidiophores and it is spherical in shape	Sporulation	*Fusarium species*
A3	A greenish filament was observed that changes to powdery greenish brown after few days. It is yellowish on the reverse side	Septate hyphae, mycelium and branched conidiophores. It has a red pigment, and the edge is surrounded by whitish margin	Sporulation	*Penicillium species*
A4	A creamy to white colonies with smooth appearance	Ovoid in shape	Budding cell	*Yeast*
A5	Fast growing colonies, at first white and downy, later showing yellowish-green to deep green compact tuft, only in small area of the plate	Septate hyphae, conidiophores with branched are presence, flask shaped of phialides.	Sporulation	*Trichoderma species*
A6	There are fast growing of colonies, flat, white to creamy which are raised and smooth appearance	Presence of septate hyphae branched and inform of chain hyaline.	No sporulation	*Geotrichum species*

There was increased in the moisture content level of the effluent contaminated soil (ECS). This could be because of the insufficient ventilation in the soil that might occur from the displacement of air in the soil. This may encourage water logging and reduced evaporation rate. This is in agreement with[21] who observed higher moisture content in POME contaminated soil. The concentration of phosphorus was more in ECS compared to NOS. This result aggrees with the earlier reports of[21] who stated that higher phosphorus concentration in soil polluted with palm oil mill effluents (POME) compared to oil free soil.

Conclusion

This study has shown that the POME dump site altered the physico-chemical properties of soil. The pH, organic matter, organic carbon, nitrate, moisture content and phosphorus content were more in effluent contaminated soil than in no-oil soil. This work also shows that the fungal counts in effluent contaminated soil was higher than the No-oil soil. This implies that fungi strive well in POME and could efficiently use POME as its food substrate. Therefore, fungi could be employed as a means of biodegrading and bioremediating POME polluted soil.

References

1. Choo W.C., Lee W.W., Venkatraman V., Sheu F.S. and Chee M.W. (2005). Dissociation of cortical regions modulated by both working memory load and sleep deprivation and by sleep deprivation alone. *Neuroimage*, 25(2), 579-587.
2. Osemwota O.I. (2010). Effect of abattoir effluent on the physical and chemical properties of soils. *Environmental monitoring and assessment*, 167(1-4), 399-404.
3. Eze V.C., Owunna N.D. and Aviaja D.A. (2013). Microbiological and physiochem characteristics of soil receiving palm oil effluent in Umuahia, Abia state, Nigeria. *Journal of Natural Sciences Research,* 3(7), 163-169.
4. Ma A.N., Cheah S.C. and Chow M.C. (1993). Currentl status of palm oil processing wastes management. *Wastes Management in Malaysia: Current status and Prospects for Bioremediation,* 111-136.
5. Madaki Y.S. and Seng L. (2013). Palm oil mill effluent (POME) from Malaysia palm oil mills: waste or resource. *International Journal of Science, Environment and Technology*, 2(6), 1138-1155.
6. Husaini A., Roslan H.A., Hii K.S.Y. and Ang C.H. (2008). Biodegradation of aliphatic hydrocarbon by indigenous fungi isolated from used motor oil contaminated sites. *World Journal of Microbiology and Biotechnology*, 24(12), 2789-2797.
7. Wollum A.G. (1982). Cultural methods for soil microorganisms. Methods of Soil Analysis. Agronomy No. 9. (2nd ed.) ASA. SSA.Madison, WI, USA, 781-801.
8. Barnett H.L. and Hunter B.B. (1972). Illustrated genera of imperfect fungi. *Illustrated genera of imperfect fungi*, (3rd ed).
9. Larone B.H. (1986). Important fungi: A guide to identification. *Hagerstown, Maryland: Harper and Row Publishers*.
10. Brady Nyle C. and Raymond Weil (1990). The Nature and Properties of Soils. Pearson Education 15th edition.
11. Agbenin J.O. (1995). Laboratory Manual for Soil and Plant Analysis (Selected Method and Data Analysis). 140. Zaria: Department of Soil Science, Ahmadu Bello University.
12. Kalembasa S.J. and Jenkinson D.S. (1973). A comparative study of titrimetric and gravimetric methods for the determination of organic carbon in soil. *Journal of the Science of Food and Agriculture*, 24(9), 1085-1090.
13. Bremner J.M. and Mulvaney C.S. (1982). Nitrogen-Total. In: Methods of soil analysis. Part 2. Chemical and microbiological properties, Page, A.L., Miller, R.H. and Keeney, D.R. Eds., *American Society of Agronomy, Soil Science Society of America*, Madison, Wisconsin, 595-624.
14. Juo A.S.B. (1988). Seledced Methods for Soil and Plant Analysis Manual Series No. 1. *International Institute of Tropical Agriculture. Ibadan, Nigeria.*, 3-12.
15. Nelson D.W. and Sommers L. (1982). Total carbon, organic carbon, and organic matter 1. *Methods of soil analysis. Part 2. Chemical and microbiological properties*, (methodsofsoilan2), 539-579.
16. Jackson M.L. (1958). Soil Chemical Analysis. Constable, London.
17. Emurotu J.E. and Onianwa P.C. (2017). Bioaccumulation of heavy metals in soil and selected food crops cultivated in Kogi State, north central Nigeria. *Environmental Systems Research*, 6(1), 21.
18. Wong S.Y., Mercer S.W., Woo J. and Leung J. (2008). The influence of multi-morbidity and self-reported socio-economic standing on the prevalence of depression in an elderly Hong Kong population. *BMC Public Health*, 8(1), 119.
19. Okwute Ojonoma L. and Ijah Udeme J.J. (2014). Bioremediation of palm oil mill effluent (POME) polluted soil using microorganisms found in organic wastes. *International Journal of Biotechnology*, 3(3), 32-46.
20. Okwute O.L. and Isu N.R. (2007). Impact analysis of palm oil mill effluent on the aerobic bacterial density and ammonium oxidizers in a dumpsite in Anyigba, Kogi State. *African Journal of Biotechnology,* 6(2), 116-119.
21. Atu Joy Eko., Linus Beba Obong and Ikono Ephraim (2017). The Influence of Palm Oil Effluent on the Physical, Chemical and Soil Micro Organism Diversity in Akwa Ibom State, Nigeria. *International Review of Social Sciences and Humanities,* 13(2), 14-23.