

## Use of Green Plantain Peel ash for Palm Oil Mill Effluent Treatment

\*<sup>1</sup>Ewelike N. C, <sup>1</sup>Orji, J. C, <sup>1</sup>Adieze, I. E and <sup>2</sup>Ukaoma, A.

<sup>1</sup>*Department of Microbiology, School of Biological Sciences, Federal University of Technology, Owerri, Imo State.*

<sup>2</sup>*Department of Biology, School of Biological Sciences, Federal University of Technology, Owerri, Imo State.*

\**Corresponding Author: Dr. Nicholas C. Ewelike, Department of Microbiology, Federal University of Technology, P.M.B 1526, Owerri, Imo State, Nigeria.*

### Abstract

A study was conducted to assess the possible use of green plantain peel ash as a treatment material for reducing the biological oxygen demand (BOD) and oil and grease concentrations of palm oil mill effluent (POME). The physiochemical characterization of the effluent and green plantation peel ash were carried out using analytical methods adopted from international standards and guidelines. Preliminary analysis of the effluent showed that it had high biochemical oxygen demand of 29500mg/L and oil and grease concentration of 7200mg/L accounting for its high polluting potential. Treatment of POME with different concentrations of green plantain peels ash decreased the BOD and oil and grease concentrations. Maximum BOD reduction of 87.8% was achieved when POME was treated with the highest concentration, 80mg/L (8.0% w/v) of green plantain peel ash. Similar concentration of green plantain peel ash also gave the highest reduction of 89.2% in oil and grease concentration. The use of green plantain peel ash which is locally available and cheap to procure in the treatment of palm oil mill effluent considerably reduced the effluent BOD and oil and grease. This research work, therefore, could serve as an efficient and cost effective method of improving the quality of palm oil mill effluent thereby protecting the environment from the negative impact of the effluent.

**Keywords:** Palm oil mill effluent, biochemical oxygen demand, oil and grease, treatment, green plantain peel ash.

## **INTRODUCTION**

Large quantities of palm oil are produced in palm oil mills in countries such as Nigeria, Malaysia, Indonesia and Thailand where oil palm trees grow readily. Palm oil mill effluent (POME) is the liquid waste or discharge from the final stages of palm oil production in the mills. Palm oil mill effluent is objectionable and could cause serious environmental pollution if it is discharged without treatment. Evidence of the effluent pollution often manifests in the alteration of the biological and physico-chemical properties of soil [1, 2, 3] and dissolved oxygen depletion in aquatic environment which endangers the life of aquatic organisms [4, 5, 6].

Various innovative treatment technologies have been developed and applied by palm oil mills to treat palm oil mill effluent [7, 8]. However, researchers have expressed concern over the problems associated with the existing treatment technologies and processes for palm oil mill effluent [9]. The methods are expensive and difficult to operate. In Nigeria and other developing countries, this problem causes operators of palm oil mills to discharge copious volumes of the effluent on the environment without treatment. Moreover, the residual oil in palm oil mill effluent poses a problem in the maintenance of the system and contributes to environmental pollution because palm oil is not easily degraded by microorganisms. It is, therefore, necessary to seek alternative and more efficient means of treating palm oil mill effluent that is easy and cheap to handle.

The aim of this research work is to treat palm oil mill effluent (POME) by reducing its biological oxygen demand and oil and grease using a natural material (green plantain peels ash) which is locally available and cheap to procure.

## **MATERIALS AND METHODS**

### **Collection of materials**

The palm oil mill effluent used for this study was collected from a palm oil mill located in Ohaji/Egbema Local Government Area of Imo State, Nigeria. The effluent was collected in five litre plastic containers from effluent storage tank. The effluent were analyzed within five hours of collection. Green plantain peels used to prepare green plantain peel ash were obtained as waste materials generated by local producers of unripe plantain flour in Relief Market, Owerri, Nigeria. The ash was obtained by burning 10kg of dried plantain peel into ash in the presence of air. The ash sample formed was collected and stored in a sterile container.

### **Physiochemical analysis of POME and ash sample**

The physiochemical characterization of the ash involved the analysis of the following parameters; sulphate, carbonate, salinity, pH, nitrate and metals such as calcium, iron,

sodium, zinc, lead, copper, nickel, barium, magnesium and cadmium. The physiochemical analysis of both treated and untreated POME was carried out. Effluent sample to be analyzed for metals were preserved with 2% nitric acid. Minimum sample volume of 300ml was used for the determination of total metal content. These determinations were done using standard methods for the examination of water and waste waters [10].

### **Treatment of raw POME**

Treatment of raw POME was carried out by measuring 1000mL of the effluent into 2000mL glass cylinders and treating the effluent with 5g, 10g, 15g, 20g, 25g, 30g, 35g, 40g, 45g, 50g, 55g, 60g, 65g, 70g, 75g, 80g, 85g, 90g, 95g, and 100g of green plantain peel ash. These represented 0.5% w/v, 1.0% w/v, 1.5% w/v, 2.0% w/v, 2.5% w/v, 3.0% w/v, 3.5% w/v, 4.0% w/v, 4.5% w/v, 5.0% w/v, 5.5% w/v, 6.0% w/v, 6.5% w/v, 7.0% w/v, 7.5% w/v, 8.0% w/v, 8.5% w/v, 9.0% w/v, 9.5% w/v and 10% w/v concentrations of green plantain peel ash in the palm oil mill effluent. The set ups were mounted on a shaker and incubated at ambient temperature for ten days.

## **RESULTS**

Physiochemical analysis of the raw POME showed that the effluent had high biochemical oxygen demand (BOD) of 29500mg/L, oil and grease concentrations of 7200mg/L and an acid pH 4.8 (table 1). Heavy metals like lead, cadmium and chromium were present in very low concentrations from less than 0.01mg/L for chromium to 0.03mg/L for lead.

The percentage reduction in oil and grease concentration of POME after treatment with green plantain peel ash is shown in table 2. The highest percentage reduction of 89.2% was obtained when POME was treated with 80g/L (8.0% w/v) of green plantain peel ash. The 3.0%, 4.0%, 5.0%, 6.0% and 7.0% concentrations of plantain peel ash in the effluent gave 69.4%, 72.2%, 76.2%, 78.7% and 82.5% reduction respectively. The effect of the treatment on the effluent BOD is shown in table 3. The highest BOD reduction of 87.8% was obtained when POME was treated with 80g/L (8.0% w/v) of green plantain peel ash. Other concentrations, 3.0% 4.0%, 5.0%, 6.0% and 7.0% w/v of plantain peel ash in the effluent gave 70.2%, 74.3%, 78.1%, 78.9% and 81.9% reductions respectively.

**Table 1:** Physico-chemical properties of raw POME and green plantain peel ash

Parameter	Raw POME (mg/L)	Green plantain peels ash (mg/g)
pH	4.83	11.1
TDS	71.5	
Chloride	<0.0016	
Salinity	<0.001	0.3
DO	68	
Alkalinity	0.02	
Phosphate	29.74	
Sulphate	98.18	<0.01
TSS	100	
Nitrate	0.174	3.0
TOC	269.84	
Iron	13.5	3540
BOD <sub>5</sub>	29500	
Oil and grease	7200	
COD	42200	
Copper	<0.01	3.86
Chromium	<0.01	
Calcium	17.00	340
Sodium	1.295	212
Magnesium	693	185
Zinc	0.07	10.52
Potassium	305	120
Lead	0.03	3.48
Carbonate		14.4
Cadmium		0.16
Nickel		5.46
Barium		58.39

**Table 2:** Percentage reduction in oil and grease concentration of POME treated with green plantain peel ash

Concentration of plantain peels ash used (% w/v)	Concentration before treatment (mg/L)	Concentration after treatment	Reduction (%)
0.5	7200	7182	0.3
1.0	7200	6800	5.6
1.5	7200	5640	21.7
2.0	7200	4320	40.0
2.5	7200	2650	63.1
3.0	7200	2200	69.4
3.5	7200	2040	71.2
4.0	7200	2001	73.2
4.5	7200	1900	73.6
5.0	7200	1786	76.2
5.5	7200	1555	78.4
6.0	7200	1534	78.7
6.5	7200	1354	81.2
7.0	7200	1260	82.5
7.5	7200	1008	86.0
8.0	7200	778	89.2

**Table 3:** Percentage reduction in BOD of POME treated with green plantain peel ash

Concentration of plantain peels ash used (% w/v)	Concentration before treatment (mg/L)	Concentration after treatment	Reduction (%)
0.5	29500	26300	9.1
1.0	29500	16201	45.1
1.5	29500	12625	57.2
2.0	29500	10501	64.4
2.5	29500	9432	68.0
3.0	29500	8801	70.2
3.5	29500	7864	73.3

Concentration of plantain peels ash used (% w/v)	Concentration before treatment (mg/L)	Concentration after treatment	Reduction (%)
4.0	29500	7586	74.3
4.5	29500	7506	74.5
5.0	29500	6472	78.1
5.5	29500	6400	78.3
6.0	29500	6218	78.9
6.5	29500	5637	80.1
7.0	29500	5346	81.9
7.5	29500	4425	85.0
8.0	29500	3586	87.8

(Table 3 continued...)

## DISCUSSION

The high biological oxygen demand and oil and grease values of the effluent are important, indicating that the effluent needed to be treated before it is discharged on the surrounding environment. This is in line with the findings of previous researchers that palm oil mill effluent characteristics were far above environmental health and safety guidelines, which indicates unhealthy environmental conditions with potential negative consequences for the ecosystem [11, 12]. The green plantain peel ash had high alkaline pH 11.1 and high iron content of 3540 mg/g. Other components of the plantain peels ash included calcium, sodium, magnesium, zinc and potassium. Previous researchers [13] also have reported similar physico-chemical components of green plantain peels ash.

Effluent treatment using available waste materials is increasingly being recognized as efficient and cost effective method of improving the quality of industrial wastewaters. Agricultural wastes such as bunch ash, cow dung, rice husk ash, banana peels and maize cobs have been effectively utilized for this purpose. The treatment processes involve one or more removal mechanisms, such as physical filtration, adsorption and enhanced microbial degradation. The green plantain peels ash employed in this study reduced the biological oxygen demand and oil and grease concentration of palm oil mill effluent. The mechanisms by which the biological oxygen demand and oil and grease were removed by the introduction of the plantain peels ash are likely to be by adsorption and enhanced microbial degradation. The adsorptive properties of activated plantain peels in the removal of organic and inorganic components of wastewaters have been established in scientific literature [14, 15, 16]. Previous researchers also have reported the use of organic ash in the reduction of biological oxygen demand and chemical oxygen demand of palm oil mill effluent [17].

The emulsifying action of green plantain peels ash on the residual oil in palm oil mill effluent may be responsible for the reduction in oil and grease content of the effluent. Surface-active agents (Surfactants) increase the oil-water interfacial area by emulsification. Surfactants have affinity for both oil and water so that oil tends to spread and be easily dispersed into small globules called emulsion. In the same vein, organic ash such as bunch ash and green plantain peel ash react with palm oil to produce an organic mixture which allows the oil to be emulsified or dispersed [18]. Hence, green plantain peel ash acts as dispersant when added to palm oil mill effluent. As dispersant, it is expected to enhance microbial degradation of residual oil in palm oil mill effluent. The combined effects of adsorption and emulsification followed by enhanced microbial degradation account for the reduction in biological oxygen demand and oil and grease content of the effluent.

## CONCLUSION

The use of green plantain peel ash in the treatment of palm oil mill effluent considerably reduced the effluent biochemical oxygen demand and oil and grease. The treatment material is locally available and cheap to procure. Moreover, green plantain peels constitute bulk solid wastes which themselves need management but were here being converted into good use. This research work could serve as an efficient and cost effective method of improving the quality of palm oil mill effluent, thereby protecting the environment from the negative impact of the effluent.

## REFERENCES

- [1] Hesam, K. Shreeshivadasan, C., Mohd, F., Shahabaldin, R., Tayebah, K and Ashok, K. (2018). Palm Oil Mill Effluent as an Environmental Pollutant. Available from <https://www.intechopen.com/books/palm-oil/palm-oil-milleffluent-as-an-environmental-pollutant>
- [2] Nwachukwu J.N., Njoku, O., Agu C., Okonkwo, C. and Obidiegwu, J. (2018). Impact of Palm oil mill effluent contamination on soil enzyme activities and physio-chemical properties. *Res., J. Env. Toxicol*, 12, 23-41.
- [3] Ovasogie, P.O. and Aghimien, A.E. (2003). Macronutrient status and specification of Cu, Fe, Zn, and Pb in soil containing palm oil mill effluent. *Global J. Pure Appl. Sci.*, 9, 7-8.
- [4] Awoteye, O.O., Dada, A. Arawomo, G.A. (2011). Impact of Palm Oil Processing Effluent Discharge on the Quality of Receiving Soil and River in South Western Nigeria. *J. Appl., Sci., Res.*, 7, 111 – 118.
- [5] Ezemonye, L.I.N., Okieimen, F.E. and Ogeleka, D.F. (2008). Lethal Toxicity of Industrial Chemicals to early life stages of *Tilapia quineensis*. *J. Hazard., Material*, 157, 64 – 68.

- [6] Edward, J.B., Agunbiade, R and Ayodele, A.P. (2017). Impact of Palm Oil Mill Effluent on Rivers Awemu in Ijero - Ekiti, Ekiti State, Nigeria. *J. Env. Sci, Tech. Food Tech*, 2, 53-56.
- [7] APOC Report, (2004). Palm Oil Mill Effluent and Empty Fruit Bunch as Nutrient Source in Oil Palm. *American Palm Oil Council Paper*; 58, 12-23.
- [8] Vijaraghavan, K., Ahmad, D and Abdul, M.E. (2007). Aerobic Treatment of Palm oil Mill Effluent. *J. Env. Manage*, 82, 24-31.
- [9] Paramitadevi, Y.Y. and Rahmatullah (2017). Technical problems of wastewater treatment plant in crude palm oil industry: a case study in PT SUCFIN Indonesia – Kehun Sungai Liput, Nang groe Aceli Durusalam Province. *IOP Coup Ser; Earth Env. Sci.*, 65:012048.
- [10] American Public Health Association, (1995). Standard Method for the Examination of Water and Waste water (19<sup>th</sup> ed.) American Public Health Association, Washington D.C.
- [11] Verla, A.W., Adowei, P and Verla, E.N. (2014). Physico-chemical and microbiological characteristics of palm oil mill effluent in Nguru; Aboh Mbaise, Eastern Nigeria, *Acta Chimica & Pharmaceutica Indica*, 4(3); 119-125.
- [12] Mosunmola, A.G and Olatunde, S.K. (2020). Palm oil mill effluents (POME) and its pollution potentials. A biodegradable prevalence. *Journal of Pollution Effects and Control*, 8(5); 258-262.
- [13] Oluremi, O.E., Oluyemi, A and Ajayi, O.S. (2012). Metal analysis of ash derived alkalis from banana and plantain peels (*Musa spp.*) in soap making. *African Journal of Biotechnology*, 11(99); 16512-16518.
- [14] Umokor, E.H., Oyekunle, J.A.O., Owoyomi, O. Ogunfowokan, A.O and Oke, I.A. (2014). Adsorption characteristics and mechanisms of plantain peel charcoal in removal of Cu II and Zn II ions from wastewaters. *Ife Journal of Science*, 16(3): 365-376.
- [15] Nworie, F.S, Nwabue, F, Ikelie, I.I., Ogah, A.O., Elom, N, Ilochi, N.O, Itumoh, E.J and Oroke, C. E. (2019). Activated plantain peel biochar as adsorbent for sorption of Zinc (II) ions; Equilibrium and kinetics studies. *Journal of Turkish Chemical Society*, 5(3): 1257-1270.
- [16] Emenike, P.C., Omole, D.O., Ngene, B.U and Tenebe, I.T. (2017). Assessment of KOH – activated unripe *Musa paradisiaca* peel for adsorption of copper from aqueous solution. *Cogent Engineering*, 4.1, Doi: 10.1080123311916.2017.1376488
- [17] Nur, S.H. and Zudariana, J (2020). Utilization of oil palm empty bunch ash as potential natural coagulant for palm oil mill effluent. *Garding Journal of Science and Technology*, 3(2); 178-186.
- [18] Onyegbado C.O., Iyagba, E.T. and Offor, O.J. (2002). Solid soap production using plantain peel ash. *J. Appl., Env. Manger.*, 6, 73-127.