PHYSICOCHEMICAL PROPERTIES OF EMPTY FRUIT BUNCHES (EFB) AND PALM OIL MILL EFFLUENTS (POME) FOR COMPOSTING FOR SOIL IMPROVEMENT

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ABSTRACT

Empty fruit bunches (EFB) and palm oil mill Effluents (POME), are currently been poorly utilized and dumped with no regards for the environment. Cameroon has a vast potential in biomass product ion, resultant from its many agro-industries, and presently, very little to no valorization strategy is in place for the possible reduction of industrial wastes, thereby leading to environmental pollution. The aim of this research was to characterize EFB and POME for valorization as manure compose. The EFB were chopped with a machete into tiny pieces while the POME was cooled and bottled in amber-colored bottles prior to physicochemical analyses which were carried out at HYDRAC, IRAD and CBC-HS, respectively. The EFB contained 0.35%; 0.12%; 0.5%; 0.7% of Nitrogen, potassium, Magnesium and Calcium, respectively. For the POME, temperature, pH, TS, TVS, TSS, BOD and COD were of 27.9°c, 4.87, 22.100mg/l, 1.400mg/l, 9.022mg/l, 1.260mg/l and 7,960mg/l, respectively. Based on the results, the physicochemical properties of TVS, TSS, BOD and COD in POME exceeded the stipulated amounts to be deposited into the environment without prior treatment. This therefore implies that the sustainable use of these vital agricultural by-products as manure in the agricultural sector will necessitate prior treatment in order to prevent pollution.

***Keywords**: EFB; POME; Characterization; Sustainable; valorization (composting).*

I. INTRODUCTION

The palm oil sector which produces more than 30% of total vegetal oil worldwide is regarded broadly as the primary source, and emits greenhouse gases (GHG) from the entire life cycle (RSPO, 2013). *Elaeis guineensis* is the most productive oil crop in the world and also the largest oil crop with an annual oil production of 53.3 million tons in 2012/2013, with the major palm oil producing countries been Indonesia, Malaysia, Thailand, Colombia and Nigeria (Lee and Ofori-Boateng, 2013), with Cameroon also in the top ten highest producers. FAO, (2013) reported the global production of palm oil amounted to some 50 million metric tons, having more than doubled since 2000. In the past around the 1960's when this industry was at its infancy, palm oil mills usually discharged either partially treated or raw palm oil mill effluent into nearby rivers as this was the easiest and cheapest method for disposal (Madaki and Seng, 2013). Due to its proliferation in the 1970s, the usually high BOD of POME brought stress on the environment (Er et al., 2011). Direct discharge of untreated POME into aquatic environments may cause some pollution problems; as such its treatment requires efficient and rapid technology (Singh et al., 2010). Growing international concern about environmental sustainability, public awareness and community involvement in the protection of the immediate environment has mounted pressure on manufacturing industries especially palm oil mills in Malaysia to control environmental pollution (Madaki and Seng, 2013). Renewable resources including agricultural and industrial residues have been studied extensively through microbial bioconversion processes. These cheap agricultural and food-processing by-products are used by most researchers as substrates in the fermentation processes to produce several products of economic importance (Salihu and Alam, 2012). The fact that the effect of chronic POME discharged on our agricultural soil has not been given the proper attention it deserves, may be due to lack of knowledge of its effect (Elendu, 1998; Zakaria, 2002; in Nwaogu et al., 2012).

The processing of palm oil needs large amounts of water. Thus, large quantities of POME and other wastes are been generated during palm oil milling (Ojonoma and Nnennaya, 2007). Presently CDC has three palm oil mill with similar operational capacity depending on the season and according to Yinda et al. (2013) tons of these Palm Oil Extraction Wastes (POEW) are generated daily, at the CDC oil mills having an operational capacity of about 25tons/hr processing approximately 200 tons of FFB per day and they are usually not treated and dumped directly into the surrounding environment thereby depleting aquatic habitats and also emitting GHG which are a major concern to the environment.

Sumathi (2004); Rupani et al., 2010; Madaki and Seng, 2013), all recommends that POME has to be treated efficiently to avoid environmental hazard especially as they are acidic in nature as such altering microbiological and physico-chemical properties of soil that will affect soil fertility (Madaki and Seng, 2013). They remain a reliable and sustainable resource as it is important to fulfil energy needs and the Oil palm waste is a reliable resource because of its availability, continuity and capacity for renewable energy solution (Abdullah and Sulaiman, 2013). However, in the case of Cameroon, due to lack of commitment and innovative sustainable technologies for managing POME and EFB generated, this industry contributes to environmental pollution, emission of greenhouse gases, coupled with underutilization and biological resource wastage especially as the quality of the decanters are old and always malfunctioning. Therefore, there is need for this industry to find simple, practical and efficient systems for managing their wastes so as to preserve the environment while maintaining a sustainable economy as Cameroon envisions emergence by 2035. Thus, this study aims at evaluating the characteristic properties POME and EFB from the Cameroon development corporation (CDC), and their associated environmental impact in order to propose alternative sustainable management methods to these wastes.

II. METHODS AND MATERIALS

a. Study Site

The study area is Mondoni, which falls under Tiko sub-division, in the South West Region of Cameroon. The study area lies between latitude 4° 10’0” N and 4° 12’0” N, and longitude 9° 26’0” E to 9° 26’0” E of the Greenwich Meridian. The climate of this area is equatorial type, comprising of sub-humid tropical climate (Amungwa and Zanke, 2017). The weather is largely controlled by equatorial and tropical air masses, characterized by average mean temperatures of 25° C and rainfall of 1,700mm (Molua, 2006). The main human activities in the region are agriculture, petit businesses and works in factories and plantations (Amungwa and Zanke, 2017).

b. Palm Oil Mill Extraction Wastes

The Palm oil mill extracted waste samples used in this study were collected at the Mondoni factory using two amber-colored bottles for the POME, and EFB were collected, by chopping with a machete a method used by Ma et al. (1996), then they were sun-dried and sealed in plastics before taken to the laboratory. The physico-chemical properties of the POME and EFB were tested in a laboratory for the verification of their quality and the latter was tested for its NPK properties. These samples were bottled in sterilized amber bottles that were autoclaved and taken to the laboratory of HYDRAC, CBC-HS pharmacy and IRAD Bambui.

c. Data collection

Fieldwork consisted in conducting observations and surveys within the milling factory using digital camera and a GPS for sampling spots and with the assistance of some workers, samples were collected for POME and EFB, which were carried out using recommended measures as stipulated by MINEP (2008), which was done strategically with respect to milling hours. A Calibrated HANNA instrument was used to get the in-situ measurements of temperature and pH. Also, to complete the data collection process, interviews and open discussions was carried out with some of the factory workers to get complementary information. As for secondary data and information, bibliographical documents were reviewed.

d. Analytical Methods

For the methods used in investigation of the COD and BOD properties of the POME is the standard AFNOR, NT T90-101 and AFNOR, NT T90-103 methods respectively at HYDRAC Douala, whereas gravimetric methods were used for the investigation of the solid particulate materials. Direct distillation method using steam distillation was used at IRAD, whereas ashing of EFB was done in a Carbolite model ELF 11/6B at 500°C. These ash samples were analyzed for K using Ion Selective Electrode (ISE), on an analyzer model 9705C whereas Mg and Ca ions were analyzed according to the BP 2012.VOL. IV.

III. RESULTS AND DISCUSSIONS

Studies have been carried out by authors such as Suhaimi and Ong, 2002; Ojonoma and Nnennaya, 2007; Kavitha et al., 2013; on composting EFB and treatment POME separately, but in Cameroon very little studies has been done on jointly composting these wastes after preliminary treatment. The results obtained from this research were based on characterizing the physicochemical properties of both the EFB and POME and quantifying their respective amounts produced as described in the following section.

a. Elemental Physical Analysis of EFB

The suitability of any biomass for reuse depends on its characteristics. The physical characteristics of EFB from processed fresh fruit bunches is shown in Table 1.

Table 1: Elemental analysis of EFB

Parameter	Mg %	Ca %	N %	K %	Moisture content
Results	0.48	0.69	0.347	0.12	64.67 %

Table 1, corresponds slightly to the findings of Kavitha *et al.,* (2013); RSPO, (2013) who reported that the empty fruit bunches contained 0.55% of N; 0.02% of P and 1.28% of K, which show there is any much difference with obtained results from studies for Nitrogen but there exist a significant different in the percentage of Potassium of more than ten times the obtained value which is possibly from the utilization of fertilizers rich in potassium. Mohammad et al., (2012), did show that these values signifies that empty fruit bunches can be optimized and used as bio-fertilizers as carried out by Suhaimi and Ong, (2002), but Deraman, (1993), reported that EFB is also composed of 45-50% cellulose and about equal amounts (25-35%) of hemicellulose and lignin these woody substrate further indicates that the empty fruit bunches are hard to degrade, there by necessitating the chopping into smaller sizes to facilitate the breakdown and release of the N, Mg, K and Ca content.

b. The Physicochemical Properties of POME

Table 2: Physicochemical properties of POME

Parameters measured	Accepted Cameroon Norms	Obtained results of POME
Temperature (T)	25°C < T > 35°C	27.9
pH	6 < pH > 9	4.87
TSS	TSS ≤ 50mg/l	9022.0 mg/l for POME
TVS	NA	1400.0 mg/l
TS	NA	22100.0 mg/l
BOD	40mg/l ≤ BOD ≥ 80mg/l If daily flow ≤ 30kg/day	1260mg/l for POME
COD	100mg/l ≤ COD ≥ 200mg/l If daily flow ≤ 100kg/day	7960mg/l for POME

NA = Not Available

These results (Table 2) showed congruence with the studies of other authors like Ahmad et al. (2003); Najafpour et al. (2006); Choorit and Wisarnwan (2007) as reported by Salihu and Alam, (2012) but with significantly lesser values as seen in Table 3.

Table 3: Comparative physicochemical results of other authors

	pH	BOD mg/l	COD mg/l	TS mg/l	SS mg/l	TVS mg/l
Ahmad et al. (2003);	4.7	25,000	50,000	40,500	18,000	34,000
Najafpour et al. (2006)	3.8 – 4.4	23,000 - 26,000	42,500 – 55,700	ND	16,500 – 19,500	ND
Choorit and Wisarnwan (2007)	4.24 – 4.66	62,500 – 69,215	95,465 – 112,023	68,854 – 75,327	44,680 – 47,140	4,045 – 4,335

ND= Not Determined

Comparatively, these obtained results (Table 2), though lesser than those reported by other authors, is way above the limit as outlined in the Cameroonian norms (MINEP, 2008); but like RSPO (2013) demonstrated, the efficiency of the decanters at the mill play a vital role on the quality of the effluents, contrastingly in Cameroon most of the decanters are outdated which inevitably has to make the resulting values higher. This is not the case because at CDC, huge amount of water is used for extracting the crude palm oil, which thereby dilutes the effluents reducing the pollutant load as seen in Figures 1 and 2 below. Like Temu *et al.* (2013), shows that the suitability of any biomass as feedstock for the production of other, bio-products usually depends on its chemical characteristics. The obtained results exhibit characteristics that are essential for valorization especially by integrating these effluents with EFB for the production of compost. The studies of fertilizer Trisakti et al. (2018), equally shows where composting of oil palm EFB was mixed with activated liquid organic for valorizing the waste. At the Mondoni area, wasted land is the obvious recognizable feature within the field with no flora around the vicinity (Figure 1 & 2), but from afar is pungent odor that is perceived. Due to the high biological and chemical content in the POME as demonstrated by Table 2; it results to in the pungent odor from release gases and the high biological and chemical contents makes it difficult for any flora to strive within this environment. The whitish colour seen on figure 2, are bubbles from the release gases and the reddish colour seen on figure 1, is from the crude palm oil that is not captured that together with the water been used in the process.

Figure 1. Fresh POME

Figure 2. Old POME

IV. CONCLUSION

Proposed integrated reusage of EFB and POME for soil amendment in agro-industries is now becoming a viable option for most plantation industries. POME and EFB are both of biological origin from plants and from the results of their physicochemical characteristics and from the observed field (Figure 1 & 2), they lead to the environmental pollution. Whereas, a combined reusage of partially treated POME to reduce the biological and chemical load, and adding to chopped EFB, through compositing will serve as a welcomed valorization strategy as initially showed by Salihu and Alam, (2012), this will lessen the amount of wasted land and reduce the amount spent on purchasing fertilizers. Lew, (2020) reported enhancement in nutrient content as a result of the addition of bone-meals, fishmeal and bunch ash to EFB + POME in weight ratio of 1:1 in the presence of 50 earthworms (Eisenia Fetida), while Salihu and Alam, (2012) showed that they existed considerable amounts of macro and micronutrients in the final compost during co-composting of EFB with partially treated POME on a pilot scale. Thus, this will be a viable option for the valorization of all the enormous amounts of agro-industrial wastes resulting from the palm oil processing units around the country, thereby reducing the inherent threat of environmental pollution that they pose.

V. ACKNOWLEDGEMENT

We are grateful to the Cameroon Development Corporation (CDC), Mondoni Mill Factory, Tiko for providing working space for this research.

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