International Journal of Biotechnology and Biochemistry
ISSN 0973-2691 Volume 17, Number 1 (2021) pp. 13-18

http://www.ripublication.com

Physico-chemical and Microbiological Properties of Palm Oil Mill Effluent from South Eastern Nigeria

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Abstract

The physicochemical and microbiological characteristics of palm oil mill effluent (POME) from South Eastern Nigeria were determined using standard methods for examination of water and wastewaters. The results showed that palm oil mill effluent contained relatively low level of sodium, potassium, calcium, magnesium and iron. None of the heavy metals like lead, mercury and cadmium was present. However, the concentration of nitrate was relatively high, 7013mg/L. This explains why POME had served very well as a food and feed substitute for chickens and pigs. The total dissolved solid and total suspended solids were relatively high 71.5mg/L and 8300mg/L respectively. The biological oxygen demand (BOD_5) and the chemical oxygen demand (COD) were also high, 29500mg/L and 42200mg/L respectively. The high BOD_5 and COD values are important, indicating that the effluent needed to be treated before discharged into the surrounding environment or into any body of water. The presence of the following microorganisms, *Clostridium* sp*, Proteus* sp*, Pseudomonas* sp *and Micrococcus* sp is important because most of these are pathogenic, hence could be responsible for some human infections. Since palm oil mill effluent has high BOD_5, COD and contains pathogenic microorganisms, POME is capable of polluting fresh water reserves and land, and, therefore, must be disposed of in some acceptable manner. In most cases, preliminary treatment is recommended before discharge.

Keywords; POME. Characteristics. Microbiological. Physicochemical. BOD. Oil and grease. Pathogenic microorganisms. Metals.

INTRODUCTION

Palm oil is an important product in tropical areas where palm trees grow readily. The oil is extracted from the mesocarp of the fruits of the palm trees (*Elaeis guineesis*). Palm oil mills produce large quantities of palm oil in Malaysia, Indonesia, Thailand and in some West African countries including Nigeria. Besides the main product (crude palm oil), the mills generate many by-products and liquid wastes which may have a significant impact on the environment if they are not properly managed.

Large quantities of water are used during extraction of crude oilfrom the fresh fruits and about 50% of the water result in palm oil mill effluent (POME)[1,2]. Fresh POME is a thick brownish slurry. Its temperature is around 80 to 90^{O}C and contains very high concentration of organic matter including oil and total solids.

In Nigeria, palm oil mill effluent is discharged into the environment in its raw form especially by small scale operators [3]. Large and medium scale mills also produce copious volume of liquid waste (POME) from the processing lines. The POME discharged from an oil mill is objectionable and could pollute streams, rivers or surrounding lands [4].

Much concern has been expressed on the environmental impact of palm oil mill effluent. Some of the possible effects of untreated POME on the environment include environmental degradation such as damage to vegetation and wild life [5], odour emission which in turn attracts flies and vermin [6], dissolved oxygen depletion in aquatic environment which endangers the life of aquatic organisms [7] and alteration of the physico-chemical properties of agricultural soil [3].

In view of the negative environmental impact of palm oil mill effluent, the need to protect our environment through effective waste management method is greatly desired. This implies that the nature and the properties of palm oil mill effluent should be ascertained and established through effective wastewater quality assessment as a guide to adopting appropriate waste management methods for the effluent. The microbiological and the physico-chemical composition of palm oil mill effluent is also important with respect to requirements for various uses and disposals.. A better understanding of these characteristics will enable us manage the effluent better.The aim of this work was to determine the microbiological and physicochemical characteristics of palm oil mill effluent from South Eastern Nigeria.

MATERIALS AND METHODS

Sample collection

The palm oil mill effluent (POME) used for this work was collected from palm oil mill in Ohaji/Egbema Local Government Area of Imo State, Nigeria. The effluent was collected in five litre plastic containers from effluent storage tanks, and placed in ice cooler to maintain temperature during transportation to the laboratory. All effluent samples were analyzed within 5 hours of collection.

Physicochemical analysis of the effluent

The physicochemical characteristics analyzed included COD, BOD_5, oil and grease, pH, total suspended solids (TSS), total dissolved solids (TDS), phosphate, sulphate, sodium, potassium, calcium, magnesium, iron and heavy metals such as lead, mercury and cadmium. These determinations were done using standard methods for examination of water and wastewater [8]. The determination of metals including heavy metals were done using a Unicon Solar Atomic Absorption Spectrophotometer (AAS).

Microbiological Analysis of the Effluent

The microbiological analysis was limited to determination of bacterial and fungal contents only. The method used for bacterial determination was pour plate method in a nutrient agar/MacConkey agar plates incubated at 37^{o}C for 24hours. Fungal determination was carried out on malt extract agar plate incubated at 25^{o}C for up to 7 days. Bacterial identification was done according to Bergey's manual of Determinative Bacteriology using prescribed procedures which included Gram staining and other standard biochemical tests necessary for the identification of the bacterial isolates. Fungal identification was based on general morphological characterization. In each case a small portion of the mycelium was collected with a sterile dissecting needle, placed in a drop of 0.5% methylene blue on a clean microscopic slide. This was covered with a cover slip and examined under microscope using X40 objective lens. The observed fungi were cross-matched with established standard for proper identification.

RESULTS

The results of the microbiological analysis of POME are shown in tables 1 and 2. The analysis showed that various genera of bacteria and fungi were present in the effluent. The following bacteria were isolated, *Clostridium* sp*, Micrococcus* sp*, and Bacillus* sp (table 1). Fungi isolated included *Mucor* sp*,Aspergillus* sp*, Rhizopus* sp *and Fusarium* sp (table 2).

Table 1: Bacterial genera isolated from ADAPALM palm oil mill effluent

Organisms	Percentage of Occurrence
Clostridium sp	11.1
Micrococcus sp	16.7
Proteus sp	11.7
Staphylococcus sp	22.2
Pseudomonas sp	16.7
Bacillus sp	22.2

Table 2: Fungal genera isolated from ADAPALM palm oil mill effluent

Organisms	Percentage of Occurrence
Mucor sp	23.5
Aspergillus sp	29.4
Rhizopus sp	23.5
Fusarium sp	23.6

Table 3. Physico-chemical analysis of ADAPALM palm oil mill effluent

Parameter analysed	Concentration (mg/l)
pH	4.8
TSS	8300
TOD	50.7
Nitrate	7013
Phosphate	27.7
Sulphate	95.2
BOD_5	29500
COD	42200
Oil and grease	7200
Ammonium	15.3
Iron	13.5
Copper	<0.001
Chromium	<0.001
Calcium	17.0
Sodium	1.27
Magnesium	693
Cadmium	Nil
Lead	Nil
Mercury	Nil
Zinc	0.07
Potassium	305

The result of the physico-chemical determination of POME are shown in table 3. A total of 21 parameters were determined. The parameters included pH, total suspended solids (TSS), phosphate, sulphate, biological oxygen demand (BOD_5), chemical oxygen demand (COD), oil and grease, ammonium, iron, copper, chromium, calcium, sodium, magnesium, cadmium, lead, mercury, zinc and potassium. The results of the various determinations showed that the raw POME had a pH 3.8, oil and grease was 7200mg/L, BOD_5 was 29500mg/L, and chemical oxygen demand was 42200mg/L. Total suspended solids (TSS) was 8300mg/L, nitrate: 7013mg/L, sulphate: 95.2mg/L, phosphate: 27.7mg/L, ammonium: 15.3mg/L, sodium: 1.27mg/L, and potassium: 305mg/L. None of the heavy metals such as lead, cadmium and mercury was present.

DISCUSSION

Effluent characterization using standard methods is widely accepted as an effective method of ascertaining the possible effect of a given industrial wastewater on the environment. Such analytical methods often involve determining the biological and physico-chemical components of the effluents as carried out in this study. The high BOD_5 and COD of the palm oil mill effluent accounted for its high polluting potential [9]. The concentration of the nitrate was also high. This probably explains why POME has served very well as animal feed and as a common ingredient in most animal feed [10]. The high concentration of nutrient in palm oil mill effluent equally explains why POME in various forms had been successfully applied on land to improve plant growth and yield [11, 12].

The result of the microbiological analysis revealed that POME contained some genera of bacteria and fungi. These include *Clostridium* sp, *Proteus* sp*, Pseudomonas* sp *Micrococcus* sp*, Bacillus* sp, *Staphylococcus* sp, *Mucor* sp*, Aspergillus* sp*, Rhizopus* sp *and Fusarium* sp. The ability of these microorganisms to survive in POME may be associated with their ability to secrete extracellular enzymes which degrade free fatty acids in POME for their carbon and energy source [13]. The high nutrient content of POME may also stimulate their growth and other cellular components synthesized from the waste. The presence of the following organisms, *Clostridium* sp*, Proteus* sp*, Pseudomonas* sp *Micrococcus* sp among others is important because most of these are pathogenic, hence could be responsible for some human infections.

CONCLUSION

The results of this study showed that palm oil mill effluent contained high organic matter and some pathogenic microorganisms. POME is, therefore, capable of polluting fresh water and land, and must be disposed of in an acceptable manner.

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