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Comparative Analysis of Selected Physicochemical Properties of Palm Oil Mill Effluent (POME) and Fresh Water in Niger Delta

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Abstract: **The physicochemical analysis of Palm Oil Mill Effluent (POME) and fresh water in Niger Delta was carried out and the results compared. POME and fresh water samples were collected every 14 days and same analysed for a total period of Eighty-Four (84) days. Some of the parameters analysed include temperature, pH, Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD). This was done to ascertain the extent POME affects our environment and its susceptibility to corrosion. The range of results of the analysis for POME were temperature (23.3^0C – 24.5^0C), pH (5.59 – 6.75), Chemical Oxygen Demand (120.4mg/l – 430.8mg/l), Biological Oxygen Demand (13.4mg/l – 64.92mg/l) and that of the fresh water were temperature (23.1^0C – 25.2^0C), pH (6.31 – 7.42), Chemical Oxygen Demand (10.56mg/l – 42.3mg/l) and Biological Oxygen Demand (2.95mg/l – 5.78mg/l). The results showed that POME varied from that of fresh water, depicting that POME has the potential of affecting our environment adversely.**

Keywords: **fresh water, mill effluent, palm oil, physicochemical, Niger Delta.**

1. INTRODUCTION

Palm Oil Mill Effluent (POME) is the wastewater generated by palm oil processing mills which contains oil, grease, and suspended solids. Upon discharge from the mill, POME is in the form of highly concentrated dark brown colloidal slurry of water, oil, and fine cellulosic materials [1]. POME is a wastewater generated from palm oil milling activities which requires effective treatment before discharge into watercourses due to its highly polluting properties. Palm oil mill effluent is a highly polluting material, due to its high biological oxygen demand (BOD), low pH and colloidal nature [2]. POME is the voluminous liquid waste that comes from the sterilization and clarification processes in milling oil palm. The raw effluent contains 90-95% water and includes residual oil, soil particles and suspended solids [3].

Palm oil mill effluent (POME) is a wastewater generated from palm oil milling activities which requires effective treatment before discharge into watercourses due to its highly polluting properties [4, 5]. The characterization of wastewater is the essential step in the design of any wastewater treatment plant (WWTP) in the industry as conducting pilot-scale tests to obtain design and operating parameters is time-consuming and expensive [6]. Characterization of POME had been conducted in various studies which only involve parameters that were listed as discharge standards by local environmental authorities and those that were significant to the results of the chosen treatment methods [7].

No chemicals are added during the production of palm oil; thus, it is a nontoxic waste. Upon discharge from the mill, POME is in the form of highly concentrated dark brown colloidal slurry of water, oil, and fine cellulosic materials [8]. Pollution associated in the palm oil mills has high biological oxygen demand (BOD) imposed by the organic effluents, chemical oxygen demand (COD), low pH, high temperatures, excessive solids, oil and grease. These parameters, in isolation or

together has a major impact on the metals used in the mills and in the effluent treatment system [9].This paper compares the physicochemical properties of the POME and that of fresh water in order to determine the environmental impact palm oil mill effluent could have on the immediate environment where it is discharged. This knowledge gap in literature prompted this study.

2. MATERIALS AND METHODS

2.1 Materials

The following equipment were used in the course of this research.

pH meter with glass electrodes, Electrical conductivity meter, Thermometer, measuring cylinder, Weighing balance, Analytical balance, Desiccators, Plastic bag, Conical flask, Pipette, Burette, conical flask, beaker, Acetone, Erichrome blackT indicator, Standard buffer solution, Ammonia buffer solution, 0.02m EDTA solution, Potassium chloride solution, Hydrochloric acid, Distilled water.

2. 2 Methods

2.2.1 Fresh Water Collection

Fresh Water sample was collected from a borehole situated close to the palm oil mill at Umukerenyi-Apani in Ikwerre Local Government Area of Rivers State.

Water sample was collected in a plastic container pre-treated by washing it with 0.1M dilute hydrochloric acid and sun-dried. At the sample collection point, the plastic container was first rinsed with the water to be collected. Fresh water was filled to the 25Litre calibrated mark on the plastic container.

2.2.2 Palm Oil Mill Effluent (POME) Collection

Palm oil mill effluent (POME) sample was collected from a Palm Oil Mill situated at Umukerenyi-Apani in Ikwerre Local Government Area of Rivers State. POME was collected in a plastic container pre-treated by washing it with 0.1M dilute hydrochloric acid and sun-dried. At the sample collection point, POME was filled to the 25Litre calibrated mark on the plastic container. All samples were transported immediately to the laboratory for analysis.

2.3 Determination of Physicochemical Properties

2.3.1 Determination of pH

The water sample collected was transferred to a clean beaker. The pH meter was switched on and calibrated with freshly prepared buffer solution of 4.0, 7.0, and 9.2 by carefully adjusting the calibration knob. Thereafter, the electrode/probe of the pH meter was inserted into the beaker with sample and the pH of the sample was read directly from the digital display on the meter.

2.3.2 Determination of Temperature

The apparatus was prepared by ensuring the availability of a calibrated and accurate thermometer for temperature measurements, and a suitable container was set up for the samples, allowing for easy immersion of the thermometer. Representative samples of both POME and fresh water were collected in clean containers, ensuring that the samples were free from any contaminants, and each sample container was clearly labeled for identification. The temperature measurement process involved immersing the thermometer into each sample, ensuring that the sensing element was fully submerged. Sufficient time was allowed for the thermometer readings to stabilize, ensuring accurate temperature measurements, and the temperatures of each sample were recorded.

2.3.3Determination of Chemical Oxygen Demand (COD)

The determination of Chemical Oxygen Demand (COD) for both fresh water and Palm Oil Mill Effluent (POME) was conducted following a standardized and meticulous procedure. A 250ml aliquot of fresh water was carefully warmed to 27ºC and subsequently transferred to a meticulously cleaned flask. To initiate the COD reaction, 10ml of 0.0125M $KMnO_4$ and 10ml of 20% v/v H_2SO_4 were added to the water sample. The mixture was gently agitated and then incubated at 27ºC for duration of 4 hours. Throughout the incubation period, the mixture was periodically examined. As the pink color of

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permanganate began to diminish, 10ml of 0.0125M $KMnO_4$ was added to ensure the continuity of the reaction. Following the completion of the 4-hour incubation, 1ml of KI solution was introduced into the mixture. The subsequent titration was carried out using 0.0125M $Na_2S_2O_3$, with starch employed as an indicator. The titration continued until the blue color just disappeared and the calculation of COD (mg/l) was performed [10].

2.3.4 Determination of Biological Oxygen Demand (BOD)

The BOD of POME and fresh water was determined using the following procedure. The method involved filling the samples to overflowing in an airtight bottle of the specified size and incubating them at the specified temperature for 5 days. Initially, dissolved oxygen (DO) was measured, and after incubation, the BOD was computed from the difference between the initial and final (DO). The initial (DO) was determined shortly after the dilutions were added, and all oxygen uptake occurring after this measurement was included in the BOD measurement.

To prepare the samples, one milliliter (1ml) each of $MgSO_4$, $CaCl_2$, phosphate buffer, and $FeCl_3$ were added to 1L of each water sample. The solution was thoroughly shaken to saturate the dissolved oxygen, and this solution was used to dilute the samples. One hundred milliliters (100ml) of the samples were measured into different one-liter flasks and made up to the 1L mark with the dilution water previously prepared. The dilution sample solution was then poured into BOD bottles and subsequently incubated at 20°C in the dark for 5 days. For the determination of initial dissolved oxygen, three hundred millimeters (300ml) BOD bottles were filled with the previously prepared diluted samples, and the initial dissolved oxygen (DO) was determined using the Winkler's method. After the 5-day incubation period, the final dissolved oxygen (DO) was determined using the same procedure mentioned above and BOD calculated [10].

3. RESULTS AND DISCUSSION

3.1 pH

Fig.1 below shows the pH of Palm Oil Mill Effluent (POME) and fresh water environment with respect to time.

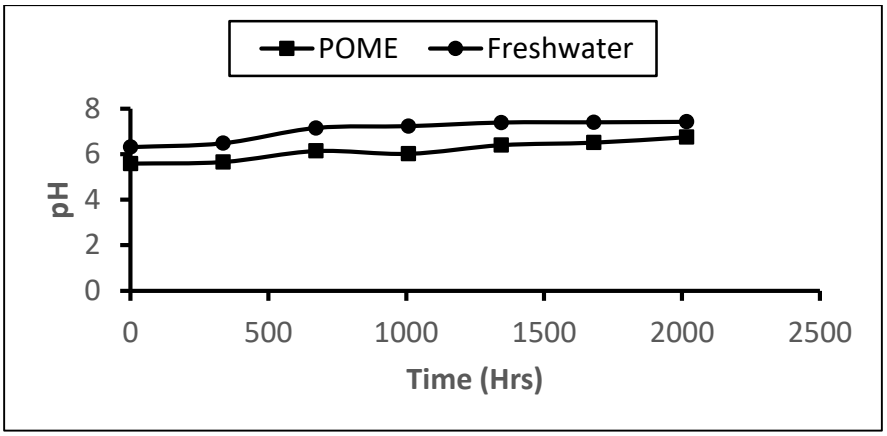

Fig1: pH (POME) and Fresh Water Environment with Time

The pH level was observed to be higher in the fresh water environment compared to the palm oil mill effluent (POME) environment as shown in Figure1 above. The pH of POME exhibited a slightly acidic nature initially but consistently increased over time. This may be due to the decrease in metallic ions and organic as a result of their consumption by micro organisms present in the POME [11, 12]. The increase in the pH of fresh water with respect to time can be as a result of loss of some of the metallic constituents and organic matter which served as nutrients to the microorganisms in the water body [13, 14].

3.2 Temperature

Fig. 2 below, illustrates the variation of temperature in POME and fresh water with time. Temperature is also an important physicochemical parameter. The temperature values of both the POME and fresh water showed no much variation.

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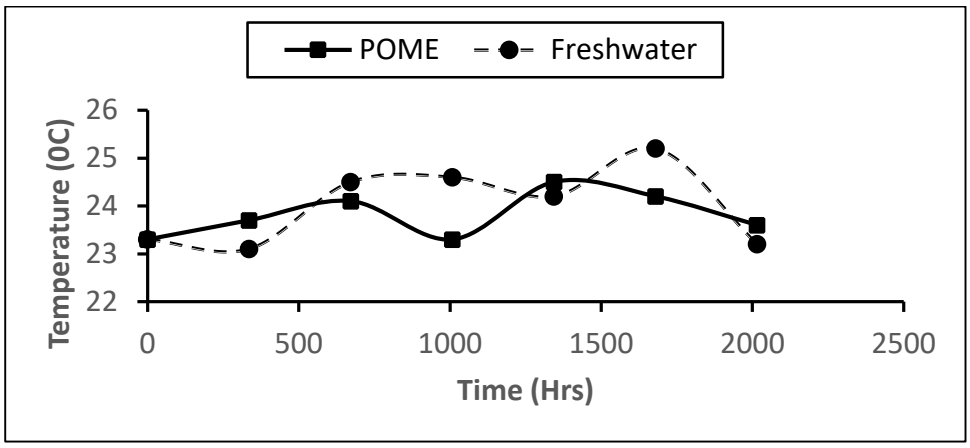

Fig. 2: Temperature of POME, and Fresh Water versus Time

3.3 Chemical Oxygen Demand

In Fig. 3, it is evident that the chemical oxygen demand (COD) of palm oil mill effluent (POME) surpasses that of fresh water.

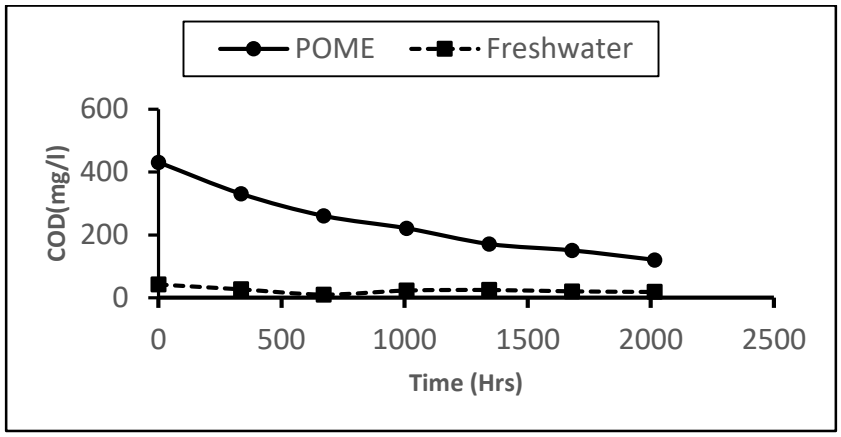

Fig. 3: COD of POME and Fresh Water with Time

The level of COD suggests that the POME contains too much organic material, which reduces the level of dissolved oxygen in the POME. Since POME is discharged into the environment, it is evident that its effect on the immediate environment is harmful [15, 16, 17]. In contrast, the COD in fresh water decreased from 43.2 mg/l to 10.56 mg/l, remaining relatively constant after 1006 hours of the experiment.

3.4 Biological Oxygen Demand

Examining Figure 4, it becomes apparent that the biological oxygen demand (BOD) in palm oil mill effluent (POME) exceeds that of fresh water. This discrepancy can be attributed to the elevated microbial activities found in POME compared to fresh water. The greater the BOD, the more rapidly oxygen is depleted in the water body [18, 19]. Of course, the effect of low oxygen in any environment cannot be over emphasized. The high level of BOD as seen in the POME result undoubtedly affected the living organisms within the environment where it is discharged. The decreasing BOD of fresh water and POME can be as a result of Microbial Decomposition of Organic matter. BOD is a measure of the amount of oxygen required by aerobic microorganisms to decompose organic matter in water [20, 21, 22]. Initially, when fresh organic matter was present in the water, the BOD was high because microorganisms are actively consuming oxygen to break down the organic compounds. Over time, as the organic matter is broken down and consumed, the microbial activity decreases, leading to a reduction in BOD [23, 24].

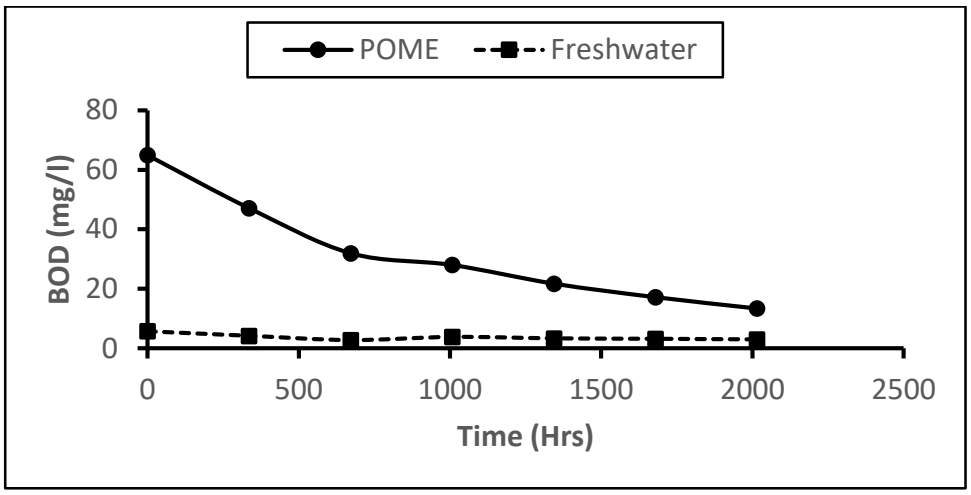

Figure 4: BOD of POME and Fresh Water Sample versus Time

4. CONCLUSION

The physicochemical analysis of Palm Oil Mill Effluent (POME) and fresh water in Niger Delta was carried out. The results of the analysis showed vividly that the POME values varied greatly from the standard and that of fresh water samples. This undoubtedly shows that POME has the potential of affecting our environment adversely within the range of parameters investigated. Hence, it is the opinion of this study that POME should be properly treated and adequate measures taken before it is discharged into the environment.

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