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Review Article

Palm Oil Mill Effluents (POME) and its Pollution Potentials: A biodegradable Prevalence

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ABSTRACT

Palm Oil Mill Effluent (POME) refers to the effluent obtained from palm oil production in the mill at the final stage. It shows the presence of residue oil and suspended solids, its potentials to pollute both ecological niches have been attributed to the most intricate environmental turmoil for the 21st century. The use of biotechnological processes involves microorganisms, with the sole aim of providing a solution to environmental pollution problems, this is rapidly growing in recent decades where POME hydrocarbons and its derivatives are concerned. This paper presents a state of the art review on palm oil mill effluent pollution, prevalence, remediation methods, its environmental potentials and biodegradation as a panacea. However, the significant development of its execution, major limitations together with the future expectation are summarized and discussed. Conclusively, hydrocarbons are been removed by both mechanical and chemical methods from the hydrocarbons-polluted site have restricted viability and can be expensive, thus, Biodegradation remains the promising technology for the treatment of polluted site because of its cost-effectiveness and complete mineralization.

Keywords: Biodegradation; Environmental pollution; Palm oil mill effluent and microorganisms

INTRODUCTION

Palm oil mill effluent (POME) which is also known as Palm oil effluent (POE), Palm oil slurry (POS), Palm oil sludge (POS), Oil palm slurry (OPS), oil palm sludge (OPS), decanter cake etc., Among all territorial name been given, Palm oil mill effluent seems to summarize it's content which is defined as the voluminous liquid waste that originates from the sterilization and clarification forms in milling oil palm. It is wastewater produced from palm oil milling exercises which require successful treatment before release into nature because of its exceptionally polluting properties. Thus, POME is being treated via palm oil mills before evacuating it into the streams and rivers. Palm oil mill effluent is termed to be a highly polluting material and researchers have done so much in their studies to find ways of removing its threat to the environment. The composition of the effluent is from different sources and are obtained from palm oil, water, sand and solid (suspended and dissolved). Water which composed of 93-95%, solidly composed of 3-4% and oil composed of 0.5-2% are various composition as a percentage of total sludge [1].

The use of biotechnological forms including microorganisms, with the target of taking care of environmental contamination issues, is quickly developing, in ongoing decades, where POME and its side-effects are concerned. Microbial Degradation forms, which exploit microbial breaking down of organic and inorganic substances, can be defined as the use of microorganisms to remove environmental pollutants of soils, water and sediments [2].

The process by which microorganisms such as bacteria, fungi and other biological activity act on material by naturally disintegration is called Biodegradation. The biological treatment relies immensely upon a consortium of microorganism's activities, which operate the organic substances present in the POME as enhancements and in the end debase these organic issues into a simple by-product, for example, methane, carbon dioxide and hydrogen provided, and water. The biological treatment process requires a huge pond to hold the POME set up for the successful biodegradation, which routinely takes a couple of days depending upon the sort and native of the microorganisms [3]. Besides, to improve the viability of this medication procedure, incredible mono or joined the culture of plausible fungi and microscopic organisms in biodegradation treatment of POME waste. Accordingly, the problem of converting POME into an environmentally benevolent waste requested a proficient treatment and viable disposal strategies.

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PREVALENCE OF POME

The palm oil industry has turned out to play an essential role in agricultural industries based in Indonesia and Malaysia which produce a great amount of oily liquid wastewater globally referred to as palm oil mill effluent (POME) [4-6]. Nowadays, the palm oil business is developing rapidly and transforming into an imperative agriculture-based industry in these two countries.

The numbers of palm oil factories have increased generally, at starting with 10 plants in 1960 moved to 410 operating mills in 2008 in Malaysia. At least 44 million tons of POME was produced and are expanding each year in Malaysia [7], especially as a result of the activity of the legislature to advance the palm oil industry. While the palm oil industry has been perceived emphatically for its commitment toward monetary development and quick improvement, it has additionally added to environmental pollution because of the creation of huge amounts of by-products during the process of oil extraction [7,8].

The two greatest oil palm producing nations are Malaysia and Indonesia situated in Asia. They are rich in endemic and forest-dwelling species [9]. Malaysia is a tropical rainforest region and is Palm Oil prosperous nation with regular assets. Presently, Oil palm includes the biggest real acreage of cultivated land in Malaysia [10,11]. The total oil palm grounds from 1970 to 2000 has extended from 320 to 3338 ha. In the year 2003, there was more than 3.79 million ha of land under palm oil development, possessing over 33% of the complete developed region and 11% of the absolute land region of Malaysia [11,12]. Palm oil, palatable oil, is gotten from the substantial mesocarp of the fruit of oil palm (*Elaeisguineensis*).

One hectare of oil palm produces 10–35 tons of fresh fruit bunches (FFB) per year [13]. Malaysia produces about 41% of the world's supply of palm oil and as at the year 2005, Malaysia accounts for the world highest percentage of global vegetable oils and fats trade [14]. The expectancy of oil palm is over 200 years and has about 20-25 years of economic life. It takes 11-15 months of the nursery period for plants and 32-38 years for the first harvest for the month of planting. It takes 5–10 years for palm oil plant to reach the highest yield. The global production of palm oil is shown in 2007 and ten years after is shown in Figures 1 and 2.

VARIOUS MEANS OF REMEDIATING POME

Bacteria as Hydrocarbon Degraders

In recent years, many microbial ecologists have identified various microbial species that are effective degraders of hydrocarbons in natural environments. Hydrocarbon biodegradation and its level of persistence in the environment are influenced by different factors which include the presence of viable microbial biomass that are capable of degrading the hydrocarbon pollutants, hydrocarbon chemical structures and the optimal environmental conditions that can support the activities of microbial degradation [15,16]. Many of these microbial consortia have been isolated from heavily contaminated areas. They were isolated base on their capacity to utilize different carbon sources, for example, aliphatic and fragrant mixes and their chlorinated derivates. The driving force for hydrocarbons biodegradation is the capability of microorganisms to utilize hydrocarbons to satisfy their energy needs and cell growth. Consortia cultures of microorganisms complete more broad biodegradation of oil than unadulterated cultures [16]. In numerous ecosystems, there is now a satisfactory indigenous microbial community equipped for broad oil biodegradation, given that ecological conditions are positive for oil-debasing metabolic action [17].

Phytoremediation (Green aquatic plants)

Due to the organic nature, POME is highly polluting for example the ecosystem can be devastated by the high content of COD and BOD including heavy metals and its discharge to an environment.

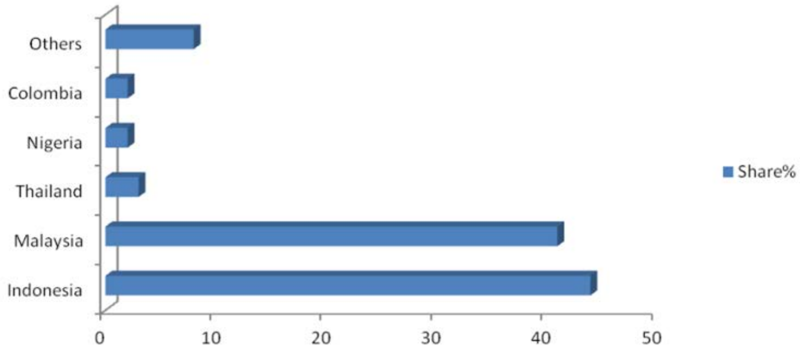

Figure 1: World palm oil production in 2007 [3].

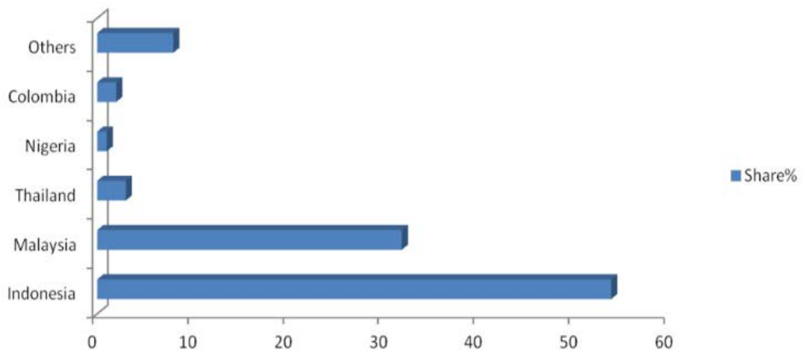

Figure 2: World palm oil production in 2017 [15].

Also, a huge amount of nutrients such as phosphorous, nitrogen and potassium are present in this waste [18], which is potential for algae growth medium. To decrease these waste loads, POME is commonly treated through biological procedures in facultative anaerobic ponds, anyway, the effluent emanating of these ponds is still greater than the threshold limit required by Indonesia Government.

Phytoremediation is defined as an economic method used to decrease the waste load in soil and wastewater. It includes the application of green aquatic plants such as water hyacinth, lotus, or by the free-living organisms i.e. microalgae or microscopic organisms that comprise the plant's rhizosphere to remove unsafe environmental toxins, for example, overwhelming metal, pesticides and xenobiotics, a natural compound, poisonous sweet-smelling contaminations and corrosive mine waste [19-21] shown the breakthrough research of phytoremediation by applying aquatic plants and as well decreased heavy metals (Al^{3+}, Fe^{3+}, Zn^{2+}, Pb^{2+}) in industrial wastewater using cumbungi (*Typhadomingensis*). Meanwhile, Kutty et al. [22] also agreed with the work of Ajayi and Ogunbayio[24] which utilized water hyacinth (*Eichhorniacrassipes*) as a bio-accumulator plant for municipal wastewater treatment. However, these research outputs focused majorly on the single phytoremediation to decrease waste contaminant, without taking any necessary action and as well on how to reapply further the effluent out of the remediation process.

The treated wastewater from sea-going plants phytoremediation despite everything contains high supplements which may be potential growth medium of microalgae. Study on the utilization of microalgae for wastewater treatment was analysed since the 1960s [23]. The recent application of microalgae for wastewater treatment has been shown by Hadiyanto et al., [22]. In that study, Hadiyanto et al., [24,25] showed that microalgae could reduce the contaminant load in palm oil mill effluent up to 70%. Furthermore, some researches such as Markou et al. [26] use olive Oil Mill Waste Water (OMWW) as a means for the growth of algae. Kitchen wastewater treatment with a variation of wastewater composition via the application of phytoremediation technology by Jongkon et al. [27].

Hadiyanto et al.,[22] study was set with a specific objective to diminish the waste contaminants by two stages phytoremediations, for example, amphibian plants and microalgae plants, respectively. By utilizing two phases of phytoremediation, they expected that the waste load can be decreased up to 98% while the biomass of green algae can likewise be acquired.

Biofilm technology

Biofilm technology used for the first time in year 1990s, for treating wastewater in Norway [28]. Numerous microbes use nutrients (organic and inorganic matters) to build a biofilm colony. Initially, the microbes connect to a reasonable surface; at that point, it begins building up the colony. Biofilm treatment has numerous focal points contrasted with ordinary POME treatment methods. For example, high movement biomass, strength to the environmental changes, diminished hydraulic retention time, low space required, adaptability in the treatment activity, and improved capacity to degrade recalcitrant compounds [29]. In 2010, the World Health Organization (WHO) had shown that 780 million people have no way to get suitable water for drinking. That issue had raised considerable concern to provide well treatment [30]. For producing high-quality water, the system involved the membrane treatment. Al-Amshawee et al., [31] had integrated Membrane with Biofilm treatment to produce a high-quality treatment.

ENVIRONMENTAL POTENTIALS OF POME POLLUTION

POME contains a great amount of acidic content, temperature, Biological Oxygen Demand (BOD), and Chemical Oxygen Demand (COD). At the point when it is released into streams it can defile drinking water for the human and animal community. The crude effluent contains 90-95% water and incorporates residual oil, soil particles and suspended solids. A modern oil palm plant produces about 2.5 t of effluent per ton of palm oil, or 0.5 ton of effluent per ton of new fresh fruit [16]. Palm oil plant effluent is an exceptionally a polluted substance and much exploration has been devoted to methods for reducing its danger to the human environment.

It tends to cause danger to the aquatic environment by making profoundly acidic conditions or causing eutrophication (where extreme algal growth happens on the surface of the water). POME contributes to global climate change when released into open-air holding ponds for remediation, thus causing methane, carbon dioxide and hydrogen sulphide to be released [32].

BIODEGRADATION AS A PANACEA TO POME POLLUTION

Palm Oil as a lipid derives its distinctive properties from the hydrocarbon nature of a major portion of the structure. The molecules are composed of long chains of carbon atoms. The hydrocarbon group is modified by the presence of small numbers of more reactive polar groups [33]. The chains can exist in several bonds but have long saturated and unsaturated monocarboxylic aliphatic pure acids. Since the major portion of the lipids in the hydrocarbon, some microorganisms have been reported to degrade oil generally causing rancidity [34].

Even though Palm fruit has been recognised to be the major source of lipase producing microorganisms, yet, studies have shown that for organisms to degrade palm oil, it must be able to produce lipase, Besides the presence of lipids and other volatile compounds, the inhibitory effects of POME on living tissues could also be due to presence of water-soluble phenolic compounds. Nilanjana et al., [35] stated that the enumeration of microorganisms and assessment of the activity of soil enzymes provide an integrative measure of the biological status of the soil. Because of these, Oyeyiola et al., [36] observed that Bacteria, Algae, Fungi, Actinomycetes, Protozoa and Viruses are the types of predominant microorganisms found in the soil. Filamentous fungi, Yeast and Bacteria have been studied by numerous authors and their findings show that they are efficient in degrading a large number of organic substances commonly found in effluents generated by oil refineries [37].

However, Pooja et al. [38] pointed out that the degradation of hydrocarbons in soil may be limited by the inability of indigenous microorganisms to efficiently metabolize these substances due to a lack of nutrients for the degrading microbiota or to a low bioavailability of hydrocarbons to degrading micro-organisms. Similarly, Eze et al., [37] studied the microbiological and physicochemical characteristics of soil receiving Palm Oil Mill Effluent in Umuahia, Abia State of Nigeria. They characterised and identified Pseudomonus aeruginosa, Staphylococcus aureus, Klebsiella species, Proteus species, Bacillus species and Citrobacter species as hydrocarbon-utilizing isolates and proceedings from their studies has served as baseline information in the present studies.

The response of resident bacteria to crude oil-polluted rivers with diesel oil was also examined [39]. They opined that bacteria species are more tolerant to varying concentrations of the diesel oil and therefore referred to such set of organisms as POME Tolerant Bacteria (PTB).

MAJOR CHALLENGES AND FUTURE PROSPECTS

A variety of microorganisms have been investigated to be capable of biodegrading oil wastewater with high profits. Anaerobic and aerobic medicines are extraordinary and proficient biological techniques for POME treatment. Nonetheless, the suspended and colloidal segments are neither viably decayed biologically nor by other regular methods because their floating on the surface of the wastewater affects the microbial cycle [40]. It is the major challenge to cause setback of the treatment system. Especially, the significant component of biological intake, microorganism assumes a significant role and major factor of the system to control reactor stability and performance. In other words, a mix of wastewater treatment and inexhaustible bio-energies creation would be an additional bit of leeway to the palm oil industry. Furthermore, the prospect of the future lies in the fact that degrading microorganisms can be isolated from POME polluted area and the degrading ability of these microorganisms is a clear indicator that these bacteria can be applied in the bioremediation techniques for biodegradation of POME to enhance treatment.

CONCLUSION

Palm oil is one of the world's most rapidly expanding equatorial crops. Even though Nigeria was the incepted palm oil-producing country, Indonesia and Malaysia remains the two largest oil palm producing countries and is rich with numerous endemic, forest-dwelling species. Discharging the effluents or by-products on the lands may lead to pollution and might cause deterioration of the environment. The treatment of these by-products requires a productive and efficient management system that will preserve the environment and check the deterioration of run water and air quality. Treatment of POME is highly important and environmental pollution must be avoided.

Therefore, the indigenous microbial strains are promising organisms for industrial usage. These microbes have direct applications in the industrial process such as bioremediation and biodegradation of wastewaters.

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