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The Utilization of Water Hyacinth (*Eichhorniacrassipes*) as Aquatic Macrophage Treatment System (AMATS) in Phytoremediation for Palm Oil Mill Effluent (POME)

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Abstract

The need for edible oil has increased resulting with a consequent boost in palm oil production. As a result, production of palm oil mill effluent (POME) which is one of the by-products of the milling process has also increased. In Malaysia, palm oil industry is identified as one of the agricultural industries that generate the highest pollution load into the rivers throughout the country. Some palm oil mills store POME in ponds or lagoons in the hope of treating and detoxifying it. Often times these ponds and lagoons overflow during bouts of heavy rainfall and intensive production. Because POME is seen as a harmful substance to the environment, it has become necessary that POME should be treated or purified before being discharged into the environment. Nevertheless, some palm oil mills in Malaysia are still unable to adhere to the Malaysia wastewater discharge limits and thus resulting to a dramatic increase in the number of polluted rivers across the country. Many technologies used in the treatment of POME require large reactor, complex designs and specification with long duration of hydraulic retention time (HRT). Thus, an alternative method which is economical to construct with less skill and little maintenance for POME treatment based on phytoremediation technology was conducted using water hyacinth (*Eichhorniacrassipes)* as aquatic macrophage treatment system (AMATS).

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The experiments were conducted in batch processes at different POME concentrations for 6 weeks. The results showed 50% reduction in BOD and COD in the pre-treated and diluted POME. Thus, water hyacinth can be used as an efficient biological agent in the treatment of pre-treated and diluted POME.

Keywords:POME; AMATS; BOD; COD; phytoremediation; water hyacinth (*Eichhorniacrassipes*)

1. Introduction

The word phytoremediation originated from ancient Greek φυτο*(phyto)*, meaning "plant", and Latin word *remedium*, meaning "restoring balance"). It describes the treatment of environmental problems (bioremediation) through the use of plants that mitigate the environmental problem without the need to excavate the contaminant material and dispose of it elsewhere. Phytoremediation is an economic method to reduce waste load in the soil and wastewater. It involves the use of aquatic plant such as water hyacinth (*Eichhorniacrassipes*), water lettuce (*Pistiastratiote*), water lotus (*Nelumbonucifera*), duckweeds or water lens (*Lemnoideae*) etc., or by the free-living organisms i.e. microalgae or bacteria that constitute the plants rhizosphere to remove harmful environmental pollutants such as heavy metals, pesticides and xenobiotics, organic compounds, toxic aromatic pollutants and acid mine drainage [15, 24, 25, 54, 57 and 58]. Phytoremediation takes advantage of the natural processes of plants [49]. The successful work of phytoremediation by using aquatic plants has been shown by various researchers, who reduced heavy metals (Al^{3+}, Fe^{3+}, Zn^{2+}, $Pb^{2+)}$ in industrial wastewater using Cumbungi (*Typhadomingensis*) [6]. Meanwhile, water hyacinth (*Eicchorniacrassipes*) has been utilised as a bioaccumulator plant for municipal wastewater treatment [56] and this was also supported by the work of Ajayi and Ogunbaiyo [59]. From these research outputs, they merely focused on the single phytoremediation strategy to reduce waste contaminants, without taking any further action on how to reuse the effluent out of remediation process.

Phytoremediation may be applied wherever the soil or static water environment has become polluted or suffering ongoing chronic pollution. Examples where phytoremediation has been used successfully include the restoration of abandoned metal-mine workings, reducing the impact of contaminants in soils, water, or air [44]. Contaminants such as metals, pesticides, solvents, explosives, and crude oil and its derivatives, have been mitigated in phytoremediation projects worldwide. Many plants such as mustard plants (*Brassica* spp.), alpine pennycress (*Thlaspicaerulescens*), hemp (*Cannabis* spp.), and pigweed (*Amaranthuspalmeri*) have proven to be successful in hyper-accumulating contaminants at toxic waste sites [52].

The most important factor in implementing phytoremediation is the selection of an appropriate plant. This is often done by considering previous applications and research. The final plant choice will be influenced by the condition of the site which will affect the plant growth. In order to select the most appropriate plant, a list of potentially beneficial plants for photo-remediation should be prepared first [61]. Studies conducted by some researchers showed that water hyacinth (*Eichhorniacrassipes*) has the potential to cleanup various wastewater due to its rapid growth [23, 26, 32, 35, 36, 37, 38, 40, 45 and 55]. The aquatic macrophage treatment system (AMATS) for wastewater treatment is mostly needed in developing countries because they are cheaper to operate and requires little skill to operate them.

1.1. The advantages and limitations of phytoremediation

1.1.2. Advantages

- the cost of the phytoremediation is lower than that of the traditional processes both in situ and ex situ.
- the plants can easily be monitored.
- there is possibility of recovery and re-use of valuable metals (by companies specializing in "phyto mining").
- it is potentially the least harmful method because it uses naturally occurring organisms and preserves the environment in a more natural state.

1.1.3. Limitations

- phytoremediation is limited to certain surface area and depth occupied by the roots.
- slow growth and low biomass require a long-term commitment with plant-based systems of remediation, it is not possible to completely prevent the leaching of contaminants into the groundwater (without the complete removal of the contaminated ground, which in itself does not resolve the problem of contamination).
- the survival of the plants is affected by the toxicity of the contaminated soil and the general condition of the soil.
- bio-accumulation of contaminants, especially metals, into the plants which then pass into the food chain, from primary level consumers upwards or requires safe disposal of the affected plant material.

1.2. Palm Oil Mill Effluent (POME)

In palm oil production, one of the major problems is the production of large volume of POME. It is often difficult to predict the characteristics of POME by using reported values in the literature because POME characteristics vary from industry to industry with respect to the palm fruit and the extraction process used. The characteristics of POME vary due to the operation and the quality control of the individual mills [62]. It also varies according to the age or species of palm fruit, management practices and dilution during production process. Some researchers believed it may also be due to variations in the discharge limit of the factory, climatic condition and the condition of the palm oil mill processing (Table 1). Since palm oil industry processes generate high volume of POME containing pollutants, their concentrations must be reduced to an acceptable level before being discharged to the surrounding environment. Thus, riverine communities and users of rivers and streams are very vulnerable to the adverse pollution impact of indiscriminate discharge of POME.

POME is a highly polluting material; it has a high organic content more than 50,000mg/L of Chemical Oxygen Demand (COD) [30]. Generally, raw POME is a colloidal suspension, non-toxic, brownish liquid, with unpleasant odour and has high temperature raging between $80^{o}C$ to $90^{o}C$ [47]. It was estimated that a processing plant with a capacity of 10 tonnes fresh fruit per hour would need a water treatment plant comparable to that required by a population of half a million inhabitants [13]. It has been estimated that 5-7.5 tonnes of water is required for the production of 1tonne crude palm oil where more than 50% of the water ends up as POME [43]. Treatability of POME has been examined with a wide range of technologies and approaches. Owing to its properties, POME can be easily treated using a biological approach.

Table 1. Regulatory discharge limit for Palm Oil Mill Effluent (POME)

PARAMETERS	MEAN VALUES	RANGE VALUE	REGULATORY DISCHARGE
pH	4.2	3.5-5.2	5-9
Oil and Grease	6,000	150-18,000	50
Biochemical Oxygen Demand (BOD)	25,000	10,000-44,000	100
Chemical Oxygen Demand (COD)	50,000	16,000-100,000	-
Total Solids (TS)	40,500	11,500-79,000	-
Suspended Solids (SS)	18,000	5,000-54,000	400
Total Volatile Solids (TVS)	34,000	9,000-72,000	-
Ammonia Nitrogen (AN)	35	4-80	-
Total Nitrogen	750	80-100	150
Phosphorus	180	-	-
Magnesium	615	-	-
Calcium	440	-	-
Boron	7.6	-	-
Iron	47	-	-
Manganese	2.0	-	-
Copper	0.9	-	-
Zinc	2.3	-	-
Lead	-	-	-

Note: all the values, except pH are measured in mg/L except pH

Sources: [7, 33]

1.3. Water hyacinth (Eichhorniacrassipes(Mart.) Solms.)

The water hyacinth (*Eichhorniacrassipes)* is perhaps one of the most commonly cited species for phytoremediation of polluted water [19 and 50]. The plant has a rapid growth rate and can hyper-accumulate nutrients as well as heavy metals [8, 9 and 14]. Water hyacinth (*Eichhorniacrassipes)* is also known for its ability to grow in severe polluted waters [27]. Water hyacinth (*Eichhorniacrassipes)* can improve the effluent quality from oxidation ponds and is a main component of an integrated advanced system for treatment of municipal, agricultural and industrial wastewaters [10, 21, 25, 31, 34, 46 and 60].

The use of water hyacinth (*Eichhorniacrassipes)* as a functional unit in wastewater treatment systems has been increasingly demonstrated and treatment regimens developed as a result of successful pilot projects [20 and 28]. Wastewater treatment with water hyacinth (*Eichhorniacrassipes)* has been successfully implemented in the USA, to produce a treated effluent attaining quality standards that would be expected from advanced secondary treatment processes [18]. Water hyacinth (*Eichhorniacrassipes)*can be used in both secondary and tertiary treatment systems, for the removal of nutrients and in integrated secondary and tertiary treatment systems, where both BOD and nutrient removal is the goal [16 and 20]. A special interest aroused in past three decade by the potential use of water hyacinth (*Eichhorniacrassipes*) as aquatic macrophage for phytoremediation in wastewater treatment. The phytoremediation abilities have been demonstrated under various conditions with excellent mineral and nutrient uptake [8, 42, and 51].

Fresh water hyacinth plant contains about 95.5% moisture, 0.04% Nitrogen, 1.0% ash, 0.06% P_2O_5, 0.20% K_2O, 3.5% organic matter. While the dry water hyacinth contains 75.8% organic matter, 1.5% N, and 24.2% ash. The ash contains 28.7% K_2O, 1.8% Na_2O, 12.8% CaO, 21.0% Cl, and 7.0% P_2O_5. The CP contains, per 100g, 0.72g methionine, 4.72g phenylalanine, 4.32g threonine, 5.34g lysine, 4.32g isoleucine, 0.27g valine, and 7.2g leucine[53].

1.4. Water Hyacinth in POME treatment

According to John (1982), pilot trials were carried out and it showed that water hyacinth can be used in the treatment of POME. Since the organic load of POME is extremely high (about 25,000mg/L BOD), it has to be pre-treated by partial digestion before water hyacinth can be expected to grow in it. Using about 25-30 day retention time, 96% BOD and suspended solids, 77% total nitrogen, 83% ammonical nitrogen and 97% oil and grease have been removed. These pilot trials showed that water hyacinth can used for POME treatment [11 and 12].

An added advantage of the water hyacinth system is that it remarkably reduces the indicative bacterial populations; more than 99% of organisms will be removed from the system as a result of the treatment. This is an important matter for consideration, especially if the treated effluent is discharged into waterways used for recreational or domestic consumptions [11]. Water hyacinth is effective in reducing the pollutants in the POME to about 90%. In the process COD is reduced to 50%, Nitrogen reduced to 88% and phosphorus reduced to 64% [22].

The aim of this study was to utilize water hyacinth (*Eichhorniacrassipes*) as aquatic macrophage treatment system (AMATS) in phytoremediation for palm oil mill effluent (POME) treatment in order to reduce the pollution load of the POME.

2. Materials and Methods

2.1. Collection of Water Hyacinth

Water hyacinth *(Eicchorniacrassipes)* was obtained at the lake margin from its natural habitat from Bandar

Tasik Selatan (8km South from Kuala Lumpur City Centre, Malaysia). The plants were rinsed thoroughly with tap water to wash off any particles attached to the surface and the roots. They were allowed to grow in a plastic trough filled with tap water in order to acclimatize and was kept away from direct sunlight and rainfall. The number of leaves, weight and height of the plants were noted.

2.2. Collection of POME

Fresh palm oil mill effluent(POME) used in the study was collected using a thermal resistant polyethylene container from a local palm oil industry, Seri Ulu Langat Palm Oil Mill SdnBhd, JalanBanting, Dengkil, Selangor Malaysia (35Km from Kuala Lumpur). In the laboratory, the sample was allowed to cool from the temperature of 90^oC to 4^oC in a refrigerator in order to prevent the POME from undergoing any further biodegradation due to microbial action prior to the study.

2.3. Analytical Procedure

This study involves two main methods which includes field measurement and laboratory experiments. Field measurement includes tests for dissolved oxygen (DO), pH and temperature whilst the laboratory experiments involve physico-chemical tests on POME before and after treatment with water hyacinth for the following parameters as well as chemical analyses of water hyacinth before and after cultivation in the POME samples (Table 8 and Table 9).

The following tests were conducted on the POME samples before and after cultivation of water hyacinth (*Eichhorniacrassipes*)

- Colour - using DR5000 spectrometer
- Dissolved Oxygen - using the DO palm top meter
- pH - using the pH meter (HANNA HI 8424)
- Salinity - using HachSension 7
- Conductivity - using HachSension 7
- Total dissolved solid - using HachSension 7
- Turbidity - using DR4000 UV-IS spectrometer
- Suspended solid - using DR4000 UV-IS spectrometer
- BOD_5 - calculated using BOD_5=DO_0-$D0_5$ x dilution factor
- COD - using DR 4000 UV-VIS spectrometer
- Nutrient Analysis - using indole coupled plasma mass spectrometry (ICP-MS)

2.4. Pre-treatment of POME using Coagulants

Coagulation was carried out using 1g/L aluminium sulphate (alum) at rapid mixing rate of 150rpm (10minutes) and slow mixing rate of 25rpm for 30 minutes. The test was done at 25°C. After 60 min of quiescent settling, samples were collected for analysis. The function of the coagulation serves as a pre-treatment for raw POME to reduce the organic load of the POME, to render the POME less toxic to water hyacinth (*Eichhorniacrassipes*) and to bring about enhanced performance for effective phytoremediation by the water hyacinth (*Eichhorniacrassipes*).

2.5. Batch Studies

In the research work, batch studies under greenhouse conditions were conducted with cultivation of water hyacinth in the pre-treated and diluted POME samples. The experimental procedure was performed in batches made up of 5 replicates of POME samples at different concentrations in sets of rectangular plastic containers (27cm length x 20cm width x 16.5cm height) with a working depth of 10cm each, a surface area of 2631cm^2 and with a capacity of 5 liters for the effluent sample. Analyses were done at the end of every 7 days throughout the 6-week retention period.

3. Results and Discussions

3.1. Visual Observation

The water hyacinth (*Eichhorniacrassipes)* leaf margins from the shoots of the plants in the various POME concentrations showed some various growth responses by yellowish spots appearing on the leaves, wilting, crisping, necrosis and final death of the plant before the end of the retention period in various concentrations and pre-treatment (Table 2 and Table 3). This was witnessed first on the older leaves and progressed to the younger ones. Since water hyacinth did not survive in the non-pretreated and undiluted POME, those systems were abandoned after the first week of monitoring because there was no remarkable difference in the sample analysis.

Table 2. Water hyacinth growth response in fresh POME at different concentration/dilutions

Samples	%POME Conc./Dilution	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
1	10	Growth	Growth	Growth	Growth	Growth	Growth
2	20	Growth	Growth	Poor Growth	Crisping	Chlorosis	Chlorosis
3	30	Poor Growth	Crisping	Chlorosis	Necrosis	Death of plant	-
4	40	Crisping	Chlorosis	Necrosis	Death	-	-
5	50	Chlorosis	Necrosis	Death	-	-	-
6	60	Chlorosis	Necrosis	Death	-	-	-
7	70	Chlorosis	Necrosis	Death	-	-	-
8	80	Necrosis	Death	-	-	-	-
9	90	Necrosis	Death	-	-	-	-
10	100	Necrosis	Death	-	-	-	-

While studying the elemental mineral uptake by the water hyacinth before and after cultivation in the POME samples at different concentrations (Table 8 and Table 9), Ingole and Bole (2003) indicated that at lower concentrations (5mg/l) of heavy metals, the water hyacinth growth was normal and removal efficiency was high. At higher concentrations of heavy metal (>10mg/l), the water hyacinth started wilting and the removal efficiency was reduced [40].

Table 3. Water hyacinth growth response in pre-treated POME at different concentrations/dilutions

Samples	**%Pre-treated POME**	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**
1	10	Growth	Growth	Growth	Growth	Growth	Growth
2	20	Growth	Growth	Growth	Growth	Growth	Growth
3	30	Growth	Growth	Growth	Growth	Growth	Growth
4	40	Growth	Growth	Growth	Growth	Poor Growth	Chlorosis
5	50	Crisping	Chlorosis	Necrosis	Death	-	-
6	60	Crisping	Chlorosis	Necrosis	Death	-	-
7	70	Chlorosis	Necrosis	Death	-	-	-
8	80	Chlorosis	Necrosis	Death	-	-	-
9	90	Chlorosis	Necrosis	Death	-	-	-
10	100	Chlorosis	Necrosis	Death	-	-	-

Table 4. BOD_5 mean values recorded for fresh POME at different concentrations/dilutions

Parameter $(BOD)_5$ mg/l	**% Fresh POME**	**Day 0**	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week5**	**Week 6**
1	10	23,170	20,132	17,720	15,430	12,802	11,190	10,150
2	20	25,010	21,450	20,100	18,700	15,500	12,400	10,900
3	30	26,105	22,894	21,718	20,190	20,015	20,005	19,998
4	40	26,750	25,670	25,350	25,200	25,205	25,200	25,195
5	50	29,440	29,425	29,502	29,458	29,450	29,451	29,435
6	60	30,780	30,756	30,716	30,702	30,700	30,695	30,690
7	70	31,510	31,506	31,494	31,478	31,480	31,464	31,452
8	80	31,515	31,508	31,502	31,506	31,500	31,478	31,482
9	90	31,517	31,504	31,498	31,500	31,480	31,485	31,478
10	100	31,520	31,513	31,515	31,510	31,496	31,498	31,480

BOD_3 measured in (mg/l)

Table 5. BOD_5 recorded for pre-treated POME at different concentrations/dilutions

Parameter $(BOD)_5$ mg/l	**% Pre-treated POME**	**Day 0**	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week5**	**Week 6**
1	10	20,106	18,790	14,300	11,830	9,808	6,998	5,250
2	20	21,650	21,000	17,500	13,350	10,300	7,800	6,500
3	30	22,354	20,988	19,762	17,540	16,880	15,602	13,240
4	40	24,500	24,150	23,700	23,100	22,900	22,250	21,950
5	50	25,105	25,098	24,982	24,964	24,896	24,904	24,786
6	60	25,624	25,602	24,996	24,880	24,896	24,864	24,782
7	70	25,870	25,662	25,600	25,598	25,588	25,534	25,218
8	80	26,150	26,076	25,540	25,460	25,320	25,325	25,315
9	90	26,430	26,306	26,278	26,246	26,130	26,102	25,980
10	100	26,980	26,998	26,842	26,614	26,418	26,410	26,409

BOD_5 measured in (mg/l)

Table 6. COD mean values recorded for fresh POME at different concentrations/dilutions

Parameter (COD) mg/l	**% Fresh POME**	**Day 0**	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week5**	**Week 6**
1	10	13,450	12,560	11,890	10,620	10,150	9,348	7,890
2	20	15,658	15,000	14,300	14,100	13,500	13,150	12,650
3	30	18,890	18,560	17,340	16,650	15,200	15,202	15,200
4	40	25,620	25,500	21,800	19,550	15,550	15,552	15,550
5	50	26,136	26,104	25,630	24,972	24,970	24,972	24,968
6	60	27,480	27,462	27,416	27,408	27,404	27,400	27,402
7	70	27,902	27,892	27,846	27,828	27,826	27,820	27,824
8	80	28,684	28,670	28,644	28,602	28,600	28,598	28,600
9	90	28,976	28,968	28,956	28,955	28,954	28,952	28,950
10	100	28,998	28,990	28,980	28,981	28,980	28,982	28,980

COD measured in (mg/l)

Table 6. COD mean values recorded for pre-treated POME at different concentrations/dilutions

Parameter (COD) mg/l	% Fresh POME	Day 0	Week 1	Week 2	Week 3	Week 4	Week5	Week 6
1	10	17,020	16,850	16,400	15,950	13,750	8,750	5,320
2	20	17,640	14,000	14,250	13,900	13,450	10,900	6,100
3	30	19,890	18,650	16,800	15,420	13,300	12,900	8,450
4	40	22,200	20,000	18,900	15,450	13,300	12,900	8450
5	50	23,560	21,780	20,208	19,640	16,300	11,700	9,600
6	60	25,450	23,500	23,150	20,670	19,506	19,502	19,500
7	70	26,020	25,630	25,200	25,010	25,005	25,000	25,005
8	80	26,780	26,650	26,410	26,100	26,098	26,101	26,094
9	90	26,798	26,740	26,736	26,722	26,720	26,722	26,715
10	100	26,810	26,805	26,850	26,840	26,845	26,842	26,840

COD measured in (mg/l)

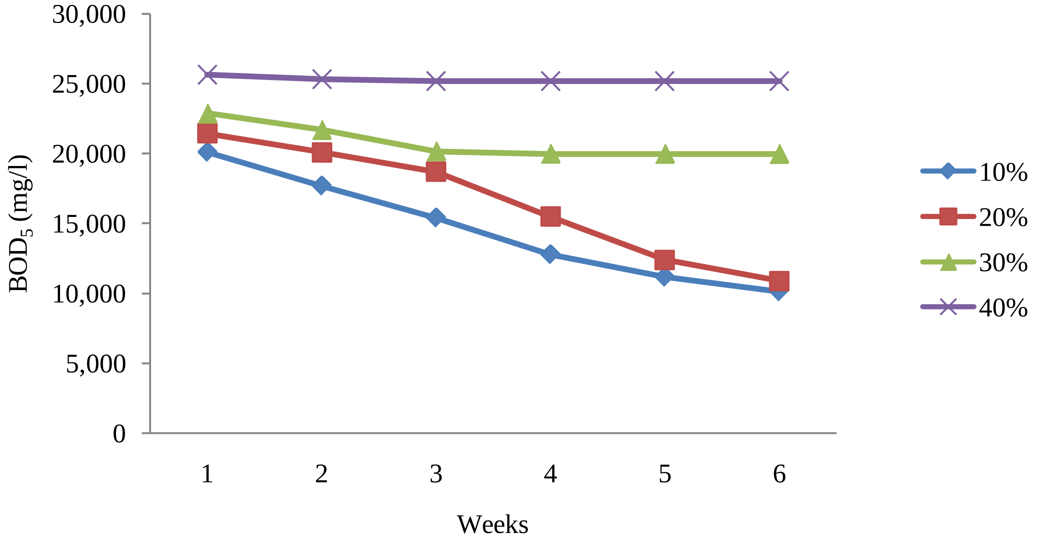

Fig. 1 BOD_5 recorded for fresh POME at different concentrations/dilutions

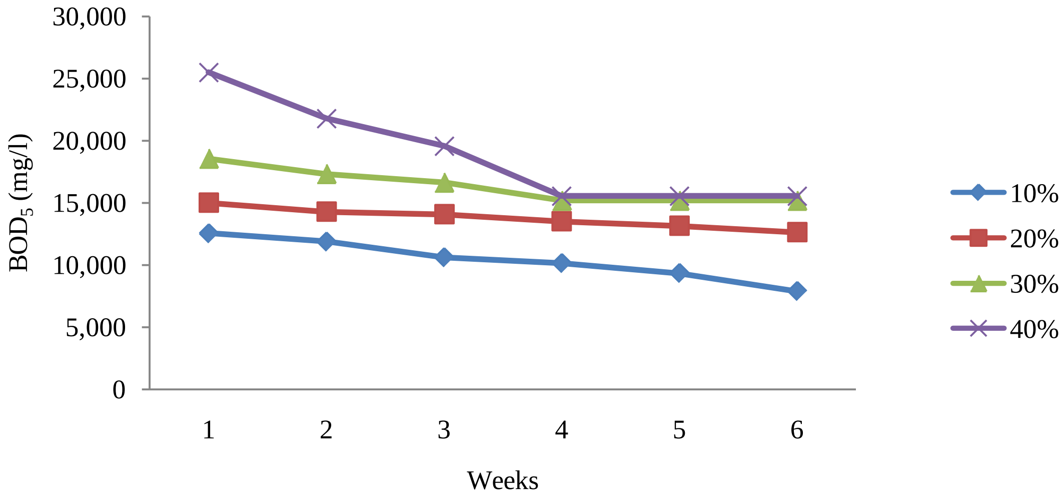

Fig. 2. BOD_5 recorded for pre-treated POME at different concentrations/dilutions

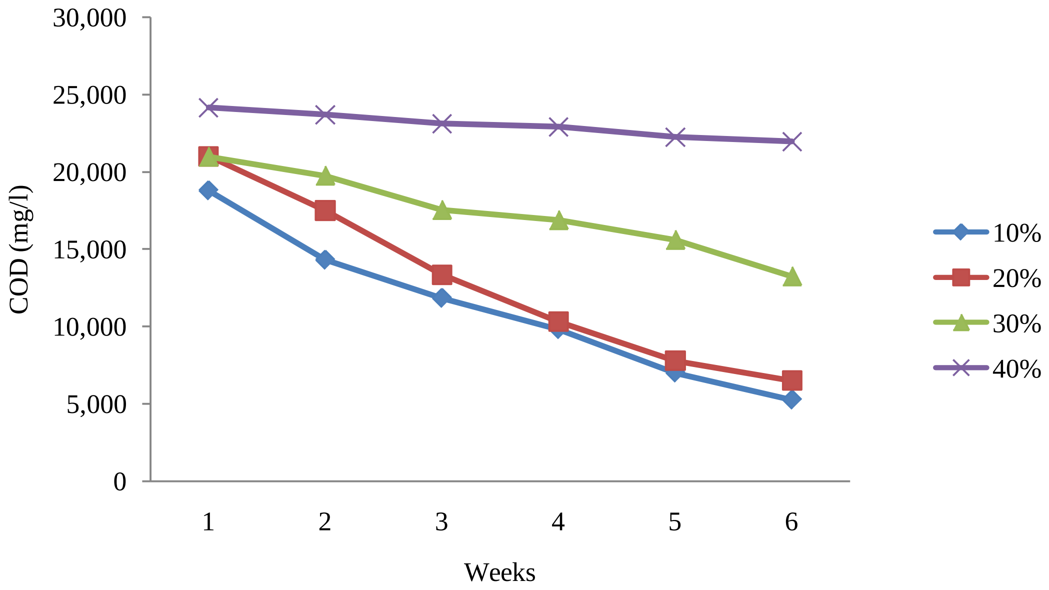

Fig. 3.COD recorded for fresh POME at different concentrations/dilutions

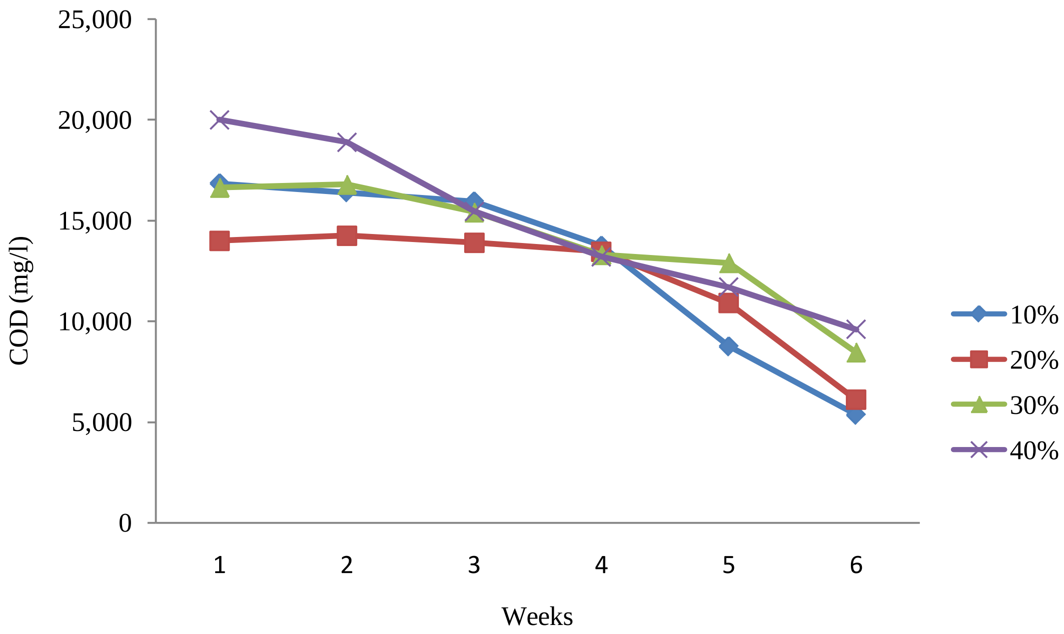

Fig. 4. COD recorded for pre-treated POME at differentconcentrations/dilutions

Table 8. ICP-MS analysis result for water hyacinth before and after treatment in 30% fresh POME

Elemental Composition	**Unit**	**Before Treatment**	**After 6 weeks treatment in 30% fresh POME**
Na	%	0.615	0.660
Mg	%	0.814	0.853
P	%	0.459	0.514
S	%	0.208	0.225
Ca	%	1.50	1.65
Mn	mg/kg	48.3	53.5
Fe	mg/kg	324	340
Co	mg/kg	0.465	0.500
Cu	mg/kg	4.12	4.45
Zn	mg/kg	130	145
Sr	mg/kg	56.0	62
Mo	mg/kg	2.79	3.10
Ba	mg/kg	45.2	49.5

Table 9. ICP-MS analysis result for water hyacinth before and after treatment in 30% pre-treated POME

Elemental Composition	Unit	Before Treatment	After 6 weeks treatment in 30% Pre-treated POME
Na	%	0.615	0.715
Mg	%	0.814	0.898
P	%	0.459	0.571
S	%	0.208	0.254
Ca	%	1.50	1.76
Mn	mg/kg	48.3	59.5
Fe	mg/kg	324	366
Co	mg/kg	0.465	0.533
Cu	mg/kg	4.12	4.84
Zn	mg/kg	130	160
Sr	mg/kg	56.0	64
Mo	mg/kg	2.79	3.33
Ba	mg/kg	45.2	51.2

3.2 Reduction in BOD and COD

At the end of each 7 days during the 6 weeks retention period, the analyses showed a gradual reduction in the pollution load. After the retention period of 6 weeks, there was a remarkable reduction in BOD and COD in the POME Samples. According to Reddy (1981), the presence of aquatic plants in wastewater depletes dissolved CO_2 during the photosynthetic activity [26]. The photosynthetic activity increases the dissolved oxygen of the POME, thereby creating aerobic conditions in the POME which favour the aerobic bacteria that work synergistically with the water hyacinth to reduce the BOD and COD. In the study, the results indicated that the introduction of water hyacinth in various POME concentrations and pre-treatment showed 50% reduction in both BOD and COD. The highest reduction in BOD and COD was recorded in samples obtained from the pre-treated POME. It was observed in the research that to achieve more than 50% BOD and COD reduction within a shorter retention period, more numbers of water hyacinth (*Eichhorniacrassipes*) shoots should be introduced in all the samples to achieve higher reductions in the pollutant load in the POME. The BOD and COD reduction recorded were very encouraging performance for the treatment of POME (Figures 1-4). It was also observed that water hyacinth (*Eichhorniacrassipes*) was able to absorb mineral elements from the POME as indicated by total increase in the elemental composition of the water hyacinth after 6 weeks treatment (Table 8 and Table 9). The result showed that high percentage of BOD and COD reduction can only be achieved using pre-treated POME instead of non-pretreated fresh POME.

4. Conclusion

This study evaluated the potential use of water hyacinth (*Eichhorniacrassipes*) in phytoremediation of palm oil mill effluent. During the experiment, the water hyacinth plants grew rapidly in pre-treated POME at various concentrations more than in the non-pretreated fresh POME. The pre-treatment for the raw POME became necessary as to reduce the organic load of the POME, to render the POME less toxic to water hyacinth (*Eichhorniacrassipes*) and to bring about enhanced performance and condition for effective phytoremediation by the water hyacinth (*Eichhorniacrassipes*). The water hyacinths (*Eichhorniacrassipes*) were able to significantly reduce the BOD and COD to about 50% and the reduction generally increased with introduction of more numbers of water hyacinths shoots into the samples. Reductions were highest in the compartments containing the pre-treated POME. It was concluded that pre-treated POME can easily be treated by phytoremediation method using water hyacinth to reduce the BOD, COD, mineral elements and other polluting parameters.It was also observed that the phytoremediation of POME using water hyacinth as aquatic macrophage treatment system is economical to construct and requires less skill with little maintenance.

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