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SHORT COMMUNICATION

POME treatment using *Spirulina Platensis* Geitler

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Abstract

Spirulina platensis is widely used as diet supplement due to its very rich protein content. *Spirulina* has not been studied widely for its potential to treat the waste water. The treatment of coloured effluent or effluent with very high suspended solids using algae is complicated. These types of effluents will not allow the penetration of light for the organism to grow. This experiment has tried a novel method of clarifying the Palm Oil Mill Effluent (POME) using commercial polymer and then treating it by growing *Spirulina*. The experiment proves that *Spirulina* can be cultivated by using POME as partial media thereby treating the POME to qualify the standards before discharge.

Key words: microalgae, waste water treatment, palm oil mill effluent (POME), *Spirulina platensis*

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Introduction

Palm oil mill effluent (POME) is a by-product in the processing of oil palm fresh fruit bunches (ffb) to produce crude palm oil (Thani et al., 1999). The raw POME, golden brownish liquor, is nutrient rich apart from containing carbohydrates, proteins and oil (Industrial Processes and Environment, 1999). Untreated fresh POME has a Biochemical Oxygen Demand of about 20,000 ppm making the liquid a strong pollutant if discharged into the water ways in its raw form (Environmental Quality Act 1974, 2005). POME is a non-toxic wastewater, and it can be treated using biological treatment processes (Hwang et al., 1978). The most common biological treatment processes employed by industry consist of a series of anaerobic, facultative and aerobic pond systems (Pavlostathis and Giraldo-Gomez, 1991). In Malaysia, the final effluent of the treated POME must comply with the discharge standards set by the Department of Environment (DOE) regardless of which treatment system is being utilized (DOE, 1999).

In 1993 alone, Malaysian oil palm mills generated about 20 million tonnes POME which would have been a source of pollution if it was discharged directly into water sources. In solving this problem the palm oil industry uses the ponding system or direct disposal on land (Wells and Charles Digby, 2005). POME can also provide material for fertilizer. The ponding system requires a reasonably large land area and close monitoring in order to comply with the environmental discharge standard prescribed by the Environmental Quality Act (1974) of less than 100 mg/l (Environmental Quality Act, 2005). Another way to dispose of POME is by evaporation (Kathiravale et al., 1997). With this process 80% of the water can be recovered and the 20% of the solid concentrate produced as a co-product can be used for fertilizer or animal feed production.

The use of algae for wastewater treatment is a known concept. The present study aims to treat POME using *Spirulina*.

Materials and methods

Algae species

Spirulina platensis purchased from Biotech International Research and Development Centre (BIRD). The alga was cultured on solid and liquid Zarrouk’s medium (Zarrouk, 1966; Borowitzka, 1992). The identification of *S. platensis* was checked (Geitler, 1925).

Palm oil mill effluent

POME is very dark coloured liquid with very high suspended solids. The properties of POME are listed in Table 1.

Table 1. Properties of POME

Test Parameters	POME (mg/l)	Standard (mg/l)	Reference
pH Value	7.8	5.5 - 9.0*	APHA 4500-H* B
BOD at 20° C	1490	50	APHA 5210 B
COD	2830	100	APHA 5220 D
Suspended solids	192	100	APHA 2540 D
Mercury	<0.001	0.05	APHA 3112 B
Cadmium	<0.001	0.02	APHA 3120 B
Chromium	<0.05	0.05	APHA 3500-Cr D
Copper	0.36	1	APHA 3120 B
Arsenic	<0.05	0.1	APHA 3120 B
Cyanide	<0.05	0.1	APHA 4500-CN* C&E
Lead	<0.05	0.5	APHA 3120 B
Chromium	<0.05	1	APHA 3500-Cr D & 3120 B
Manganese	0.97	1	APHA 3120 B
Nickel	0.04	1	APHA 3120 B
Tin	<0.1	1	APHA 3120 B
Zinc	0.23	2	APHA 3120 B
Boron	0.4	4	APHA 3120 B
Iron	12.2	5	APHA 3120 B
Phenol	NR	1	APHA 5530 B&D
Free Chlorine	<2	2	APHA 4500-Cl G
Sulphide	0.54	0.5	APHA 4500-S2 D
Oil and Grease	ND (<1)	10	APHA 5520 B

Polymers for clarifying POME

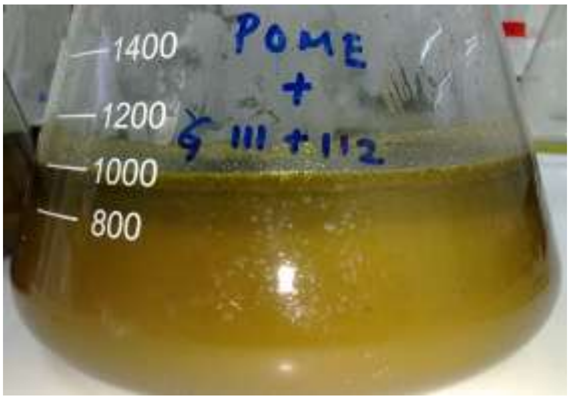
Two commercial Polymers GPF8111 and polymer GPF8112 are used. As these polymers are concentrated, the polymers were diluted for clarifying POME.

4 mL of polymer GPF8112 / GPF8112 is diluted into 100 mL of distilled water whereby, 5 mL of the polymer after dilution is added into the opaque POME samples.

Experimental procedure: Clarification of POME

4 mL of polymer GPF8111 is diluted into 100 mL of water. After dilution, 5 mL of the GPF8111 polymer is added into 100 ml of opaque sample of POME in the separatory funnel. The sample is left to flocculate for at least an hour. After 1 hour, 5 mL of GPF8112 polymer is added into it and left overnight.

Figure 1. Clarification of POME



Subculturing of Spirulina using POME

After leaving the POME samples overnight, 2 layers can be seen in the Separatory funnel. The bottom layer is discarded and the top layer is collected. The top layer is poured into a 2 L flask which will be used for the sub culturing process with *Spirulina platensis*.

In the laminar air flow 100 mL of Zarrouk's medium is measured and added into the flasks containing clarified POME samples. Next, 150 mL of *Spirulina platensis* culture is added into the same flasks. The flask is placed in a 12/12 light/dark cycle area.

The cultures are left for observance for at least a week. The major parameters which deviated from the standard for discharge such as BOD, COD, suspended solids, manganese, iron, sulphide as well as oil and grease is measured after one week. The cell density of *Spirulina* is also measured by manual cell count.

Results

The cell count of *Spirulina* increased from 5×10^4 cells/ml to 13.75×10^4 cells/ml in 6 Days. Though the growth is very slow comparatively, *Spirulina* is able to tolerate the chemical parameters of POME. The treatment is efficient to reduce the BOD to qualify for discharge standards. The treatment does not qualify the discharge standards for COD and hence it requires additional treatment methods.

Figure 1. Growth of *Spirulina* sp in POME containing minimal medium

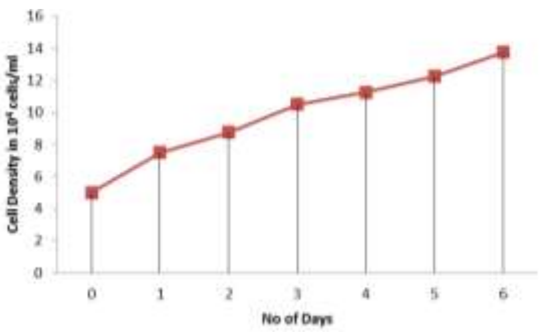


Table 1. Comparison of POME properties before and after treatment with discharge standards

Test Parameters	Before Treatment (in mg/l)	After Treatment (in mg/l)	Discharge Standard (in mg/l)
pH Value*	7.8	8.9	5.5 - 9.0
BOD at 20 C	1490	42	50
COD	2830	182	100
Suspended solids	192	25	100
Manganese	0.97	0.01	1
Iron	12.2	0.29	5
Sulphide	0.54	<0.01	0.5
Oil and Grease	ND (<1)	ND (<1)	10

- No unit

Discussion

Thus it can be safely concluded that after treatment of the composting POME using Spirulina algae, has reduced the BOD from 1490 mg/l to 42 mg/l. The pH is increased to 8.2, optimal pH for growing *Spirulina*. The Suspended solids are considerably reduced from 192 mg/l to 25 mg/l by the polymer clarification. The heavy metal content is also reduced to notable levels. Hence it is proven that the POME can be treated biologically using algae after clarifying POME for suspended solids. The reduction of BOD and COD is significant allowing the discharge of POME after treatment.

Acknowledgements

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