

# A Prospect to Develop *Chlorella* powder industry in Riau Province in order to eliminate waters pollution by Palm Oil Industry

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**Abstract:** Palm oil industries have been developing quickly in Riau Province. The study of the utilization of wastewater from the oil palm industry as a culture medium for *Chlorella* sp has been conducted from 2015 to 2017. The result of this study indicated that palm oil wastewater could promote the growth of *Chlorella* sp. The high density of *Chlorella* sp was found at a concentration of 20, % of wastewater with a cell density of  $6.5 \times 10^6$  cells/ml and biomass reached about 0.36 g/l. The concentration of nitrate in culture medium decreased from 13.8 mg/l at the beginning to 2.4 mg/l at the end, and phosphate decreased from 2.26 mg/l at the beginning to 0.17 mg/l at the end of 20 days study periods. Based on this study, it can be concluded that wastewater from Palm oil industry can promote the growth and production of *Chlorella* sp, so it is a prospect to develop *Chlorella* powder industry in Riau Province in order to eliminate waters pollution by Palm Oil Industry.

**Keywords:** *Chlorella* powder industry; palm oil waste; water pollution

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## 1. Introduction

Riau is the largest number of palm oil plantation in Indonesia with areas of 2.399.173 ha in 2014. The production of Crude Palm Oil (CPO) reached 7,047,221 ton in 2014 produced by 245 of Palm oil Industries. The Palm Oil Industry generates a large number of wastes whose disposal is a challenging task. They also give rise to highly polluting waste-water, known as Palm Oil Mill Effluent (POME), which is often discharged in disposal ponds, resulting in the leaching of contaminants that pollute the groundwater and soil, and in the release of methane gas into the atmosphere. POME could be used for biogas production through anaerobic digestion, [1].

In a conventional Palm Oil Mill, 500-700 kg of Pome is generated for every ton of processes fresh fruit bunches (FFB). Most of the Biomass residues from Palm Oil Mills are either burnt in the open or disposed of in waste ponds. The Palm Oil Industry, therefore, contributes significantly to global climate change by emitting carbon dioxide and methane.

Wastewater production from all palm oil industries in Riau is estimated to be 29.250.000 ton/year [12]. This wastewater contains biological oxygen demand (BOD) estimated to 8,200-35,00 mg/l, Chemical Oxygen Demand, 15,103 – 65,100 mg/l, Total Solid Suspended (TSS) estimated to be 1,220-50,700 mg/l, oil and lipid estimated to 150 -14,700 mg/l [8]. Therefore, it is very important to eliminate water pollution by the Palm Oil industry in Riau Province using *Chlorella* as bioremediation.

*Chlorella* is a potential supplement food source for bull calf because it is high protein and other essential nutrients when dried, it is about 45 % protein, 20 % fat, 20 % carbohydrate, 5 % fiber, and 10 % minerals. It is also abundant in calories and vitamins, [9] *Chlorella* is also suggested as an inexpensive protein supplement to the human and animal diet. Under certain growing condition, *Chlorella* yields oils that are high in poly saturated fats.

*Chlorella* is a pioneer organism living in the ocean for long periods. They are (sun) light-driven cell factories that transform carbon dioxide (CO<sub>2</sub>) into an ingredient for feed and food, free Oxygen (O<sub>2</sub>), and biomass for feedstock and bio-fuels. They can grow fast under extreme condition (salt, freshwater, alkaline, hot, etc., yield up to 10 times that of traditional crop and do not compete with traditional crops for food, and can be used marginal land. They can absorb many in-organic materials from wastewater such as nitrogen, phosphorus, potassium, magnesium, Ferrum, and others so they can be able to clean the dirty water (purify) [6]. In this study, we use wastewater from palm oil industries to grow and produce *Chlorella* powder in order to use as supplement food for bull calves in Riau Province.

## 2. Methodology

This study was conducted in three years from 2015 to 2017 in three steps: step one we call an initial study with a high concentration of palm oil wastewater, and the second steps with a low concentration of wastewater. Wastewater from Palm Oil Industry belongs to PT Perkebunan Nusantara 5 Tandun, Kampar. Riau was collected and filtered with Dahril Filter. Dahril filter is a tool specially designed to filter the palm oil mill effluent (wastewater). Dahril filter was made by a plastic drum with gravel, sand, coal and palm fibres inside. The Dahril filter was filled with wastewater through the filter substrate than the wastewater was boiled as long as 20 minutes to kill bacteria and fungi. This filtered wastewater was put in a 400-ml plastic bottle that call it Dahril Solution that can be used in this experiment. This wastewater was diluted by adding fresh water with the high concentration of 0,0 %, 25 %, 50 %, 75 %, and 100 % as a preliminary study in 400 ml- culture medium.

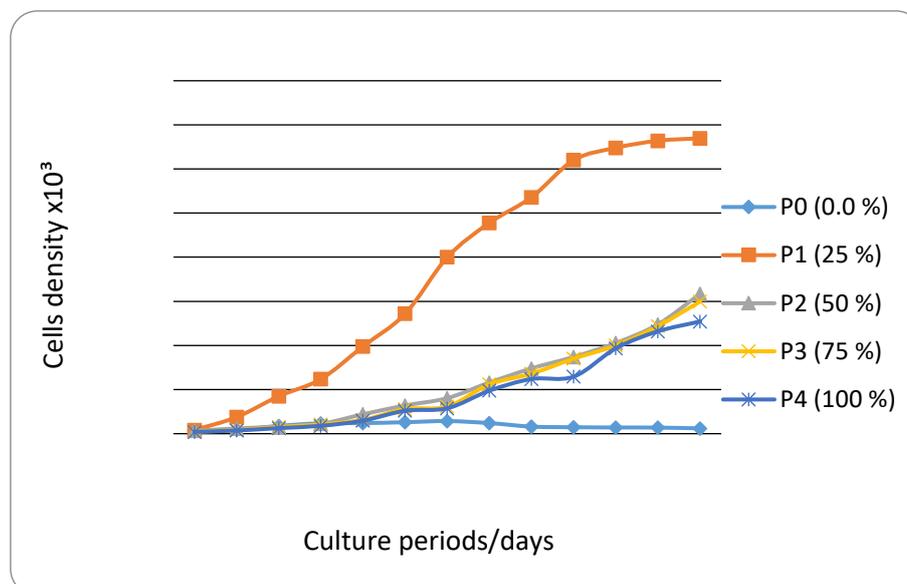
*Chlorella* sp, obtained from freshwater Aquaculture Research Centre, Depok, West Jawa, was inoculated with an initial density of  $5 \times 10^4$  cells/ml in 600 ml flasks for each treatment. All growth studies were conducted in triplicate. Chlorella was cultured in a simple incubator with continuous aeration, illuminated by two daylight fluorescent lamps with a light intensity of 2000-4000 lux and temperature between 23 to 28°C. The Chlorella density was enumerated daily for 13 d using a Thoma cytometer under a binocular microscope.

Based on the result of the initial study in treatment 1, the study was continued with a low concentration of wastewater namely 10 %, 20 %, and 30 %, and 0 % as a control. The study was conducted in 6 l-plastic bottles for 24 bottles with culture medium 4 l each bottle and continuously aerated in an outdoor room. The light comes from sunlight directly with a room temperature of about 28 to 33° C. Chlorella was inoculated with an initial density of  $5 \times 10^4$  cells/ml. The number of Chlorella cells was enumerated daily for 11 d using thomacytometer under a binocular microscope. After 11 days of culture periods, all biomass Chlorella were harvested, and dry weight of Chlorella powder was measured using a balanced (weighing). The concentration of nitrate and phosphate before and after Chlorella culture were also measured.

All biomass that collected from the second study was used as Chlorella powder to make cow biscuit as supplement food for the bull calf in the third step of this study. This biscuit was made by, 3 % Chlorella powder mix with 50 % of sago powder, 20 % wheat flour, 20 % mung pea powder, 5 %, white sugar powder, 2 % of pandanus leaf, butter, vitamin (BECOM-C) and two eggs. One biscuit of this supplement food with average weight about 12 gram each, was given to three bull calf daily in the morning before they eat normally, and three of them none as long as 12 weeks during the period of this study. Mean weight of each bull calf was measured weekly to know the effect of supplement food to growth and production of bull calf.

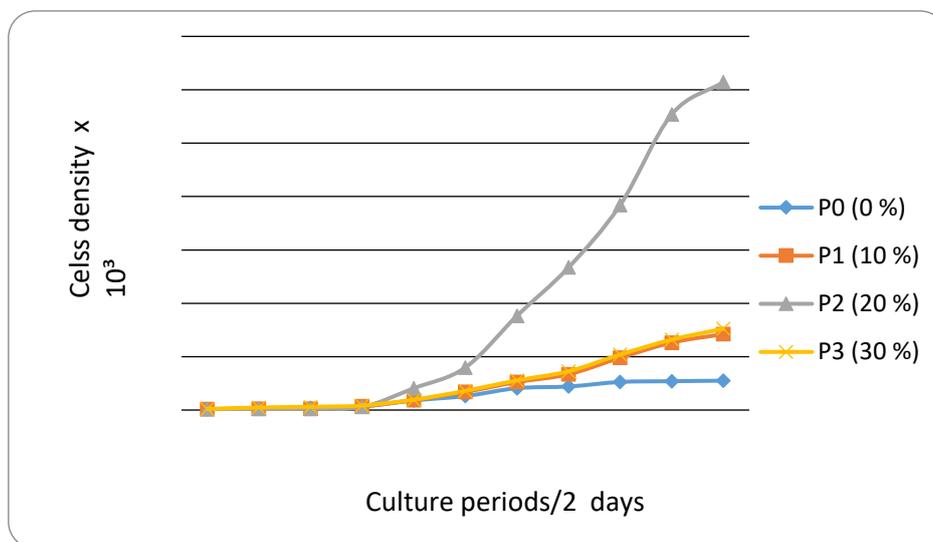
## 3. Results and Discussion

It was founded that wastewater from the palm oil industry in Riau Province supported the growth of *Chlorella* sp. The best growth of *Chlorella* was founded in the low concentration of wastewater (25 %) compared with a high concentration (50 %, 75 %, and 100 %)., with total density of  $3,3 \times 10^6$  cells/ml at day 13 (Figure 1).



**Figure 1.** The growth of *Chlorella* sp with a high concentration of palm oil wastewater.

Based on the result of this preliminary study, the experiment was continued with a concentration of 10 %, 20 %, and 30 %. The result of the second experiment, it was founded that the concentration of 20 % of wastewater was better compared to a concentration of 10 % and 30 %. High concentration of *Chlorella* sp was found in 22 days with a total density of  $6.6 \times 10^6$  cells/ml as shown in figure 2.



**Figure 2.** The growth of *Chlorella* sp with a low concentration of palm oil wastewater.

At the end of this second study, the total density and biomass of *Chlorella* were also found higher in the concentration of 20 % with a total number of 0,36 gr/l as shown in table 1.

**Table 1.** Total cell density and biomass of *Chlorella* at the end the study

Treatment	Cell density (Cells/ml)	Biomass (gr/l)
P0 (0 %)	550.667	0.05
P1 (10 %)	1.422.000	0.17
P2 (20 %)	6.145.333	0.36
P3 (30 %)	1.524.000	0.10

The biomass of *Chlorella* that collected from the second study has been used as supplement food for a bull calf. The result of this study indicated that supplement food with 3 % of *Chlorella* powder contain could promote the growth and production of the bull calf in Riau Province. After 12 weeks bull calf cultured in the cattle with supplement food given every day, the mean weight of bull calf increases from 125.0 kg to 150.0 kg or added as much as 25.0 kg compared with without supplement food was 115.6 kg in the initial study to 129.0 kg or added only about 13.4 kg. Based on this research result, it can be known that wastewater from Palm oil industry can promote the growth and production of *Chlorella* sp that can be used as supplement food for the bull calf in Riau Province.

**Table 2.** The weight (kg) of bull calf without and with supplement food before and after cultivated for 12 weeks

	Without	With supplement food
Before	115.6	125.0
After	129.0	150.0
Added	13.4	25.0

Many studies have been reported that nitrogen and phosphorus are the two main nutrients that can influence phytoplankton growth [11][10][3][4] reported that human manure and animal manures which containing a high concentration of nitrogen and phosphor could support the growth and production of freshwater green algae (*Chlorella* sp) in the bath culture medium. In this study, we also found that green algae, *Chlorella*

sp can see growth properly in palm oil wastewater, and it can also be used as supplement food for a bull calf. They can also decrease nitrate and phosphate in wastewater contain, Therefore, *Chlorella* sp can be used effectively to decrease nitrogen and phosphorus in wastewater of palm oil industry in Riau province. The concentration of nitrate and phosphate before and after *Chlorella* growth in many concentrations of wastewater from the palm oil industry can be shown in table 3 follows.

**Table 3.** Mean concentration of nitrate and phosphate before and after *Chlorella* cultured in each treatments

Treatment	Nitrate (mg/l)			Phosphate (mg/L)		
	Before	After	Decreased	Before	After	Decreased
P0 (0%)	4.1	0.4	3.7	0.40	0.09	0.31
P1 (10%)	7.7	3.3	4.0	0.83	0.11	0.72
P2 (20%)	13.8	2.4	11.4	1.16	0.17	0.99
P3 (30%)	18.4	11.8	6.6	1.38	0.68	0.74

#### 4. Conclusions

Based on this study we can conclude that wastewater from Palm Oil Industry can promote the growth and production of *Chlorella* powder that can be used as supplement food for cull calf. Highest growth and biomass production of microalgae was founded in the concentration of 29 % of wastewater with a cell density of  $6.6 \times 10^6$  cells/ml and biomass 0.36 gr/l. Then, *Chlorella* biomass as *Chlorella* powder can be used as supplement food to increase the growth and production of a bull calf. Utilization of *Chlorella* powder that culture in wastewater from palm oil industry can decrease the concentration of nitrate from 13,8 to 2.4 and phosphate from 1.18 to 0.17 mg/l.

Based on this study, it can be concluded that wastewater from palm oil industry can promote the growth and production of *Chlorella* sp, so it is a prospect to develop *Chlorella* powder industry in Riau Province in order to eliminate waters pollution by Palm Oil Industry.

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