A prospect to develop *Chlorella* industry in Riau Province, Indonesia

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Abstract. A Prospect to develop *Chlorella* industry has been conducted since 2015 to 2018. The pure chemical and waste water from oil palm industry as culture media of *Chlorella* sp. were used in this study. Result of this study indicated that pure chemical and palm oil waste water can promote the growth and product of *Chlorella* sp. The best growth of *Chlorella* sp. was found at pure chemical with cell density reached 1.6 x 10⁷ cells/ml and biomass reached 1.24 g/l. The high growth of *Chlorella* sp. in palm oil wastewater was found at concentration of 20 % with cell desity of 6.6 x 10⁶ cells/ml and biomass reached about 0.36 g/l. The concentration of nitrate in pure chemical culture medium was decreased from 15.43 to 1.46 and in palm oil wastewater was decreased from 13.8 mg/l at the beginning to 2.4 mg/l at the end and phosphate was decreased from 45.82 mg/l to 4.98 mg/l at the beginning to 0.17 mg/l at the end of 14 days culture period. *Chlorella* powder that was produced in pure chemical medium in this study can be used as *Chlorella* powder in capsule for human being and from palm oil wastewater medium can be used as supplement food for animal husbandry (calves) in Riau Province.

1. Introduction

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

*Chlorella* is a pioneer organisms living in the ocean for a long periods of time. They are (sun) light driven cell factories that transform carbon dioxide (CO₂) into ingredient for feed and food, free Oxygen (O₂), biomass for feed stock 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, kalium, magnesium, ferum, and others so they can be able to clean the dirty water (purify) [3]. In this study, we use two nutrient sources, i.e. pure chemical and wastewater from palm oil industries to grow and produce *Chlorella* sp. that can be used as a food supplement for human and animal husbandry in Riau Province.
2. Materials and Methods

Two types of nutrient sources were prepared to grow of *Chlorella* sp. One of the nutrients made by pure chemical called Dahril Solution 1, and another one made by wastewater from Palm Oil Industry called Dahril Solution 2. The materials of Dahril Solution 1 were made by manufactured chemical: 1) KNO₃ 1000 mg/l, 2) MgSO₄ 250 mg/l, 3) K₂HPO₄ 250 mg/l, NaCl 100 mg/l, CaCl₂·2H₂O 10 mg/l, then Fe-solution, 1 ml/l and trace metal solution 1 ml/l. Fe solution made by FeSO₄·7H₂O 2000 mg/l and Na₂EDTA as much as 189 mg/l per 1 liter aquades. Trace metal solutions were made by 1) H₃BO₃ 2860 gr/l, 2) MnSO₄·7H₂O 2500 mg/l, ZnSO₄·7H₂O 225 mg/l, CuSO₄·5H₂O 71 mg/l dan Na₂MoO₄ 21 mg/l per 1 liter aquades. These chemicals substances can be purchased from the local stores. The second source of the nutrient was came from wastewater of palm oil mill effluent that was filtered with the Dahril filter made by a drum that contained gravel, sand, coal and palm fibre inside as natural filters. The concentration of palm oil wastewater used in this study was 20 %.

The study was conducted in 6 liter-plastic bottle with culture medium 4 l each treatments and continuously aerated in outdoor room. The light was from direct sunlight with room temperature about 28 to 33°C. Chlorella was inoculated with initial density of 5 x 10⁴ cells/ml. The number of *Chlorella* cells density was enumerated daily for 14 d using the Haemocytometer under binocular microscope. After 14 days culture periods, all biomass of *Chlorella* were harvested and washed with pure water and dried by oven with temperature at 150 °C for 60 min. The weight of *Chlorella* was measured using a balanced (weighing). Concentrations of nitrate and phosphate before and after Chlorella culture were also measured.

Biomass that was collected from the pure chemical treatment were used to make *Chlorella* powder in capsule for human, while biomass from palm oil wastewater were used to produce supplement food for animal husbandry (calves).

3. Results and Discussions

It was found that *Chlorella* sp. was growing well in two types of nutrient sources of pure chemical (Dahril Solution 1) and wastewater from palm oil industry (Dahril Solution 2). The best growth was found in Dahril Solution 1 with cell density reached 1.6 x 10⁷ cell/ml and biomass reached 1.24 g/l compared with Dahril Solution 2 (Palm Oil Wastewater) with cells density of 6.6 x 10⁶ cells/ml and biomass 0.36 g/l in day 12 as shown in Figure 1 and Table 1.

![Chlorella Growth](image)

**Figure 1.** Growth of *Chlorella* sp. in Dahril Solution 1 (Pure Chemical) and in Dahril Solution 2 (Palm Oil Wastewater).
Table 1. Total cell density and biomass at the end the study

| Treatment         | Cell density (cells/ml) | Biomass (gr/l) |
|-------------------|-------------------------|----------------|
| Pure C (10 %)     | 15.869.000              | 1.24           |
| Palm Oil (20 %)   | 6.645.333               | 0.36           |

The biomass of *Chlorella* that was collected from pure chemical in this study was used as *Chlorella* powder in capsule for human supplement (Figure 2), with concentration of protein 44.67 %, lipid 19.84 %, carbohydrate 21.50 %, fiber 5.02 %, mineral and vitamins 9.57, Pb 0.000234 ppm and Cd 0.000277 ppt, while biomass from culture using palm oil waste was used as supplement feed for calves (Figure 3) [3]. Dahril, Mulyadi and Evawani [4], also reported that supplement food with 3% of *Chlorella* powder content can promote the growth and production of calves in Riau Province. After 12 weeks calves cultured in the cattle with supplement food given every day, the mean weight of calves was increased 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 initial study to 129.0 kg or added only about 13.4 kg. Based on their research result, it can be known that wastewater from Palm oil industry can promote the growth and production of *Chlorella* sp. biomass that can be used as supplement food for animal husbandry (calves) in Riau Province [4].

![Figure 2. Pure Chlorella powder in capsule for human supplement](image)

![Figure 3. Feed supplement contain 3% Chlorella powder for calves in Riau Province](image)

Based on the result of this study, it is found that pure chemical solution could be better to promote the growth of *Chlorella* sp. than palm oil waste water. It may be caused by high level of phosphate and nitrate in this solution.
Many studies have reported that nitrogen and phosphorus are the two main nutrients that can influence phytoplankton growth [5, 6]. Dahrl, Ahmad and Iizuka [1] [2] reported that human manure and animal manures with high concentration of nitrogen and phosphate can support the growth and production of freshwater green algae (*Chlorella*. sp.) in bath culture medium. In this study, we also found that green algae, *Chlorella* sp. can growth properly in pure chemical medium and palm oil wastewater medium and it can be also used as supplement food for human and animal husbandry (calves). They can also decrease nitrate and phosphate contents in wastewater. Therefore, *Chlorella* sp. can be used effectively to decrease nitrogen and phosphate in wastewater of palm oil industry in Riau province. The concentrations of nitrate and phosphate before and after *Chlorella* growth in pure chemical medium and wastewater from palm oil industry are shown in Table 2.

### Table 2. Mean concentration of nitrate and phosphate before and after *Chlorella* sp. cultured in each treatment

| Treatments           | Nitrate (mg/l) | Phosphate (mg/l) |
|----------------------|----------------|------------------|
|                      | Before After   | Decreased        | Before After   | Decreased        |
| Pure Chemical        | 15.43 1.46     | 13.97            | 45.82 4.98     | 40.84            |
| Palm Oil Waste       | 13.80 2.40     | 11.40            | 1.16 0.17      | 0.99             |

**4. Conclusions**

In this study we concluded that pure chemical medium and wastewater medium from palm oil industry can promote the growth and production of *Chlorella* sp. The harvested biomass can be used as raw materials for human food supplement and feed supplement of animal husbandry. High growth and biomass production of *Chlorella* sp. was found in pure chemical medium with cell density of $1.6 \times 10^7$ cells/ml and biomass reached 1.24 g/l; while at the concentration of 20% wastewater, cell density of *Chlorella* sp. reached $6.6 \times 10^6$ cell/ml and biomass 0.36 g/l. *Chlorella* sp. biomass from pure chemical medium can be used as human food supplement and biomass from wastewater of palm oil industry can be used as animal husbandry (Calves) feed supplement. The utilization of *Chlorella* sp. in pure chemical medium and from wastewater medium of palm oil industry also decreased the concentration of nitrate and phosphate. Therefore, in the large scale, *Chlorella* sp. biomass can be used as a source of food supplement for human and animal husbandry and it can also eliminate water pollution from palm oil industry in Riau Province.

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