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Study of cultivation under different colors of light and growth kinetic study of *Chlorella zofingiensis* Dönn for biofuel production

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Abstract

Chlorella zofingiensis Dönn is popular as food sources and as potential source for biofuel. In order to determine the potential of *Chlorella zofingiensis* Dönn as a source for biofuel, it is necessary to enhance its growth and to identify the carbohydrate and lipid content using red, blue, and white light as well as various salinities for the cultivation. Among the process conditions tried, cultivation using blue light at salinity 19 ppm was considered as the optimum one which resulted in greater dry weight of biomass as well as greater lipid content. However, the other process conditions, with lower dry weight of biomass, had carbohydrate as the major component so that actually the process condition selection depended on what kind of biofuel will be produced. Based on the optimum condition in interest of biodiesel production, kinetic study was ran using blue light with salinity 19 ppm. The suitable model to describe the growth kinetic of microalgae was Contois model.

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1. Introduction

Biomass-based alternative energy resource is the fourth largest energy resource after oil and gas, coal, and biogas [1]. Recently, the common biomass utilized as the energy resources are coming from crops such as palm and *Jathropa curcas* for biodiesel production [2] and corn and sago for bioethanol production. However, the conflict of demand between energy sector and food sector limit the productivity

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of this biomass-based energy resources type due to the lack of land. Thus, the productive biomass which doesn't intercept with the food sector and doesn't need huge area of land is necessary.

In the perspective of aforementioned issues, microalgae are gaining much attention as an alternative renewable source of biomass for production of bioethanol, which is grouped under “third generation biofuels” [3]. Microalgae are fast-growing microorganisms with a voracious appetite for carbon dioxide. They have the potential to produce more oil per acre than any other feedstock being used to make biodiesel, and they can be grown on land that's unsuitable for food crops [4]. Algae are adaptable organisms that are mainly aquatic and microscopic. Microalgae are unicellular photosynthetic microorganisms, living in saline or fresh water environments that convert sunlight, water and CO₂ to algal biomass [4].

As organism, microalgae were composed of several components and chemicals to support their life. Biomolecular composition of microalgae cell consists of protein, carbohydrate, lipid, and nucleic acid with various percentage of each for different microalgae species. The lipid component is suitable to be extracted and converted into biodiesel while the carbohydrate component is suitable to be fermented into bioethanol. The lipid and carbohydrate content of microalgae can be maximized through modification on its cultivation condition. Light is one influential factor to determine the profile of microalgae biomolecular composition [5]. Metabolism and growth of microalgae is regulated either by light intensity or by light spectrum. According to the level of absorbance of pigment, the blue and red lights are the best light for photosynthesis while the green light was the worst light for microalgae growth [6]. Salinity presented as another factor which influence the productivity of microalgae [7]. Therefore, this work aimed on searching for the optimum condition in *Chlorella zofingiensis* Dönn cultivation through varying the light spectrum and salinity. After the optimum condition was found, the kinetic study was executed to find the growth kinetic primarily and to ease in scaling-up the cultivation equipment or designing the continuous process production secondarily.

The microalgae species used in this work is *Chlorella zofingiensis* Dönn. *Chlorella zofingiensis* Dönn is classified as Chlorophyceae and can live either in saline water or in fresh water. This species is characterized by spherical body shape, bowl formed chloroplast, no flagella, and its reproduction is done vegetatively through self division [8]. This species had been so familiar that its use as the food supplement showed the establishment of its cultivation.

Nomenclature

μ_m	[day ⁻¹]	maximum specific growth rate of acidogenic cell
K_S	[mg sCOD/mg cell]	half-saturation constant
$Y_{X1/COD}$	[mg cell/mg sCOD]	yield of cell formation per mg soluble chemical oxygen demand (sCOD) reduction
k_d	[day ⁻¹]	death-rate constant
K_I	[mg sCOD/L]	inhibition constant

2. Materials and Methods

Materials needed in this work were aquadest, microalgae culture *Chlorella zofingiensis* Dönn, farmpon fertilizer, urea, ZA, NaCl, chlorine, phenol, H₂SO₄ 98% (Flucka), ethanol 70% (CV. General Labora), Nile Red solution, and dimethyl sulfoxide. Fertilizer media was the combination among ZA, farmpon fertilizer, and urea. Firstly, a solution was made for each. To create the solution, those three

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