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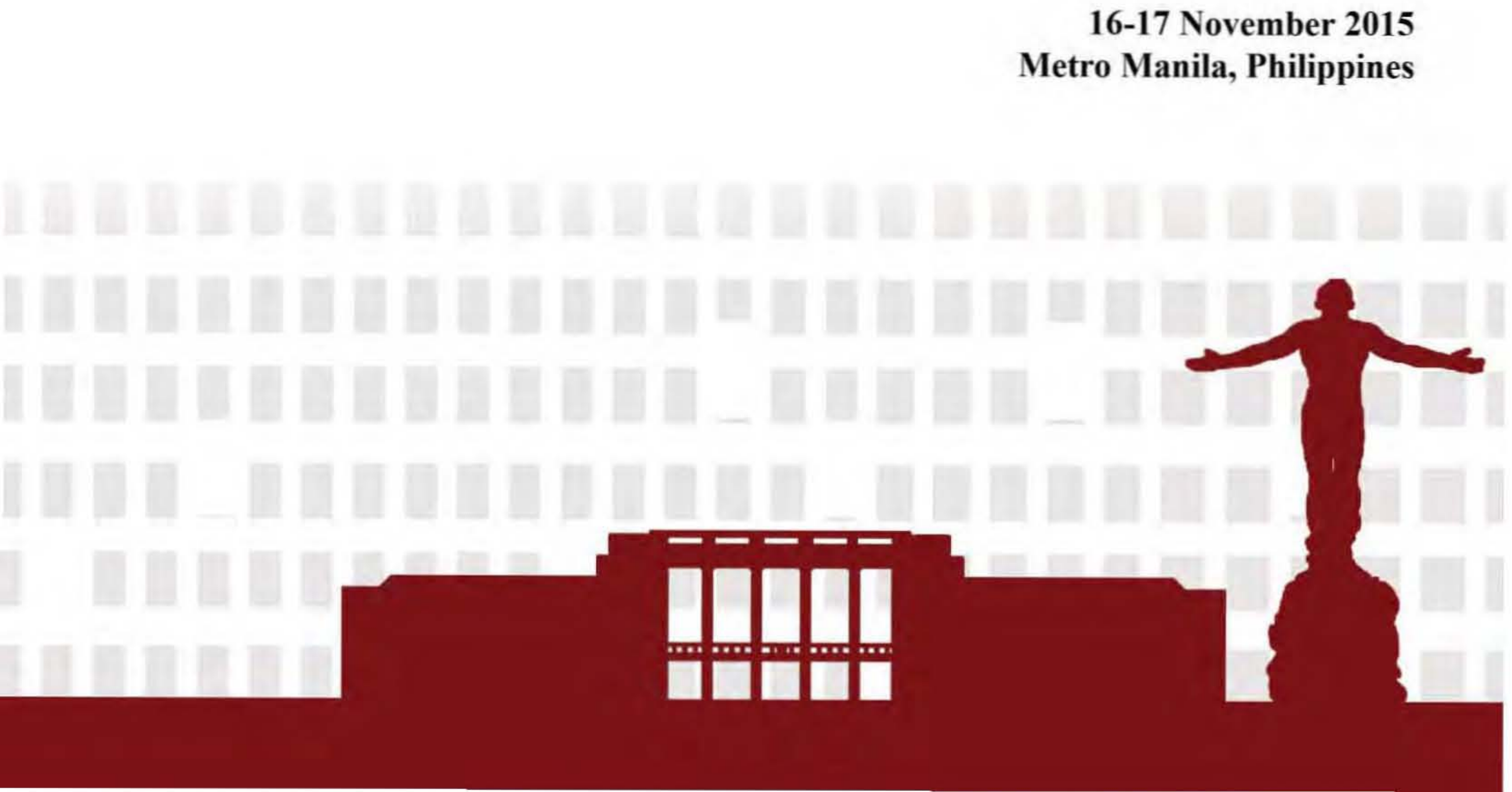

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# EFFECTS OF LIGHT SOURCES AND LIGHT WAVELENGTHS ON THE GROWTH AND LIPID CONTENT OF THE GREEN ALGA, *Chlorella vulgaris* Beij.

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## ABSTRACT

The effects of different artificial light sources (CFL and LED) and different light wavelength (blue, red, and white) on the growth and lipid content of the green alga, *Chlorella vulgaris* Beij., were investigated. Results showed both the dry biomass concentration and lipid content of the *C. vulgaris,* using CFL or LED, were in the order of white > red > blue. At each light wavelength the dry biomass concentration and lipid content of the *C. vulgaris* under LED light were both significantly higher ($p < 0.05$) than those obtained under CFL. The study showed the white LED light provided the best condition for growth and lipid accumulation of *C. vulgaris*. The use of LED light could significantly reduce the energy input for the indoor microalgal cultivation. This could help improve the economic viability of *C. vulgaris* for biofuel production, as well as other application.

**Keywords:** *Chlorella vulgaris*, CFL, LED, Microalgae, Wavelength

## Introduction

Microalgae biomass have been used as feed in aquaculture and as feedstock for food, pharmaceuticals, and cosmetics. Recently, microalgae has been considered as a promising feedstock for biodiesel production. Several factors are known to influence the growth and biomass composition of microalgae. Essentially all algal cells require light to drive photosynthetic reaction, carbon source, and other nutrients for growth and reproduction. Photosynthesis can be driven by sunlight or artificial light. Artificial light are generally considered for indoor cultivation and systems that require controlled growth condition. Light Emitting Diode (LED) could potentially replace Compact Fluorescent Lamp (CFL) as artificial light source for growing microalgae, mainly because LED have longer life span, and higher efficiency of electricity conversion compared to CFL [1]. Different algal species respond differently to different lighting condition. In this study, the effect of different CFL and LED light wavelengths on the growth and lipid content of green algae, *C. vulgaris* (Beij.) were investigated.

## Methods

The freshwater alga, *C. vulgaris*, was obtained from the Institute of Biological Sciences, University of the Philippines Los Baños. All experimental culture were grown using the BG-11, in clear polyethylene (PET) bottles with 3L working volume and initial algal concentration of 0.1 $OD_{507}$ (optical density reading at 507 nm). Algal culture were maintained for 31 days at 27±2°C, with aeration at 1.8L/min, photon flux density of 200 μmol/photons $m^2/s$, and 12/12 hr light/dark cycles. The final biomass concentration was determined gravimetrically. The algal lipid content was extracted using a mixture of chloroform and methanol (2:1 v/v), then quantified gravimetrically.

## Results and Discussions

The effects of different wavelengths of CFL and LED light on the growth and total lipid content of *C. vulgaris* is given in Table 1. As shown at each light wavelength (blue, red, and white), the dry biomass concentration and lipid content of *C. vulgaris* using LED were both significantly higher ($p < 0.05$) than those obtained using CFL. White LED light gave the highest biomass and lipid, followed by the white CFL light. This result is consistent to the fact that LED has narrow emission spectra containing about 80-100% PAR (photosynthetically active radiation, 400-700 nm) [2], while CFL emits wider spectra including wavelengths with low photosynthetic activity for *C. vulgaris*. The white light appeared to be more suitable for the growth and lipid accumulation of *C. vulgaris* compared to monochromatic light (pure blue and pure red) using either CFL or LED. This can be explained by the observation of previous researchers which reported that exposure to pure red light and pure blue light could actually cause damage in microalgae cells [3]. Between the red and blue light, better results were achieved in the former because the red light which has emission spectra between 660-700 nm contains the wavelengths corresponding to the absorption peak of major photoreceptors in photosynthesis, such as chlorophylls and phytochrome [2, 4]. The blue light was least effective for the algal growth and oil accumulation. The reason may be due to the fact that blue light (420–470 nm) has higher photon energy compared to white and red light. Hence, it is possible that the blue light caused far more damage to algal cells, i.e. by overloading the photosystem or bleaching out of pigments, which ultimately decreased the biomass and lipid content of *C. vulgaris*.

**Table 1.** The dry biomass yield (Dbm), and total lipid (TL) content, of *C. vulgaris* under different wavelengths of CFL and LED light.

| Light Source | Light Wavelength | Dbm (mg/L) | TL (%) |
|---|---|---|---|
| CFL | White | 676.67 | 19.90 |
| CFL | Blue | 20.00 | 8.87 |
| CFL | Red | 203.33 | 10.30 |
| LED | White | 866.67 | 32.07 |
| LED | Blue | 350.00 | 16.47 |
| LED | Red | 373.33 | 19.33 |

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