Light Affects Electrochemical Characterization of Electrogenic Microalgae Desmodesmus sp. A8

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Abstract. Electrogenic microalgae attached on cathode could enhance the generation of current in microbial fuel cells. For understand the electrochemical characterizations of microalgae, Desmodesmus sp. A8, as a model electrogenic microalgae, was investigated by cyclic voltammetry analysis under illumination and dark. Desmodesmus sp. A8 showed higher current response under incandescent (4.46 μA) than that under fluorescent (2.16 μA) at -0.44 V vs. Ag/AgCl, while the current decreased significantly to 0.14 μA in dark. With the increasing illumination time, current generation enhanced rapidly and reached to a certain value remained stable, finally. From the light source and working time, we demonstrated that light profoundly impacted the electricity generation of electrogenic microalgae Desmodesmus sp. A8.

1. Introduction
Microbial fuel cells (MFCs) provide new ideas for new energy production and water pollution control with the aid of electrochemically active microorganisms [1]. MFCs inoculated photosynthetic microorganisms can generate electricity from respiratory and photochemical activities [2,3]. Photosynthetic microorganisms such as Chlorella vulgaris [4] and Rhodopseudomonas palustris DX-1[5] have been applied to expand the functions of MFCs.

Microalgae produce approximately half of the atmospheric oxygen, simultaneously consuming the greenhouse gas of carbon dioxide [6]. The photosynthesis process involves in the production of reactive oxygen species and oxygen which are important electron acceptors for electricity generation in MFCs [7,8]. Besides, an additional benefit of the application of microalgae in MFCs is that carbon dioxide can be effectively reduced by algae in cathode chamber [9]. Other functions of microalgae such as N, P abortion [4], biodiesel production [10], algal biomass supply [11] and self-regeneration ability [12] increase the potential application of MFCs in renewable energy generation and wastewater treatment.

Light is one of the most important factors affecting the photosynthesis efficiency of microalgae [13]. In the present study, the effect of light on electrochemical characterizations of electrogenic microalgae Desmodesmus sp. A8 were investigated.

2. Methods and materials

2.1 Microalgae
The Desmodesmus sp. A8, previously isolated from Jimei wastewater plant (Xiamen, China) [13]. The microalga was cultured with BG11 medium under illumination [14].

2.2 Electrochemical analysis
Cyclic voltammetry (CV) was performed in a three-electrode system with platinum wire as counter electrode, 3 mm diameter glassy carbon electrode as working electrode, and Ag/AgCl (KCl, sat.) as reference electrode. During the tests, the working electrode was covered with Desmodesmus sp. A8. CV was conducted in the potential range of −1.0 to 0.2 V at a scan rate of 20 mV/s using an electrochemical workstation (Autolab 302N, Netherlands).

3. Results and discussion

3.1 Morphological characterization
The morphological characteristics of Desmodesmus sp. A8 are shown in Figure 1, the dents at the pole of the coenobia and the ribs on the cell surface are characters of Desmodesmus [15]. In cellular suspensions, two-cell coenobia were the most frequently.

Figure 1. Scanning electron microscope (a) and light microscope (b, 400×) micrographs of the cells of strain A8.

3.2 Effect of light source on electrochemical characterizations
Light source is a significant factor affecting the photosynthesis of microalga mainly due to the difference in wavelength range coverage [16]. In this study, fluorescent and incandescent lamps were used to investigate the effects of light source on electrochemical characterizations of strain A8. As shown in Figure 2, peak current of strain A8 under the incandescent and fluorescent lamps were 4.46 and 2.16 μA at -0.44 V vs. Ag/AgCl respectively, which decreased to 0.14 μA in dark.

Light distribution of the incandescent lamp was similar to the adsorption spectrum of Desmodesmus sp. A8 in the range of 660-690 nm [17]. Therefore, Desmodesmus sp. A8 under fluorescent light with lower current generation should be ascribed to a greater wavelength range of fluorescent light which are more unsuitable for the activation of chlorophyll pigments enabling A8 to produce less oxygen as the electron acceptor.
3.3 Illumination affected electrochemical characterization

To investigate the effect of illumination on electrochemical characterization of strain A8, CVs of A8 were carried out under illumination (1500 lux) and dark. As shown in Figure 3, a reduction peak was observed at potential -0.4 V. The peak current rapidly increased from 0.013 (dark) to 2.23 μA (illumination) and continuously increased to 4.26 μA after illumination for 10 hours. The current peak stayed constant as illumination time increased to 14 hours.

As shown in Figure 4, the peak current at potential -0.4 V rapidly decreased to 0.012 μA when the A8 culture condition was changed to dark, and current output stayed constant as culture time increased to 14 hours in dark.
4. Conclusions
This study demonstrated that illumination significantly enhanced electricity generation of Desmodesmus sp. A8. Peak current of microalgae was significantly promoted when A8 was illuminated with incandescent lamp compared with fluorescent lamp. This study presented an insight into improving the performance of MFCs inoculated with microalgae.

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