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Cultivation of algae consortium in a dairy farm wastewater for biodiesel production

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ABSTRACT

Dairy farm wastewaters are potential resources for production of microalgae biofuels. A study was conducted to evaluate the capability of production of biodiesel from consortium of native microalgae culture in dairy farm treated wastewater. Native algal strains were isolated from dairy farm wastewaters collection tank (untreated wastewater) as well as from holding tank (treated wastewater). The consortium members were selected on the basis of fluorescence response after treating with Nile red reagent. Preliminary studies of two commercial and consortium of ten native strains of algae showed good growth in wastewaters. A consortium of native strains was found capable to remove more than 98% nutrients from treated wastewater. The biomass production and lipid content of consortium cultivated in treated wastewater were 153.54 t ha^{-1} $year^{-1}$ and 16.89%, respectively. 72.70% of algal lipid obtained from consortium could be converted into biodiesel.

1. Introduction

Exhausted water and petroleum resources have put the viability of algal biofuel into account. Although the idea of using microalgae as a source of biofuel is not new [4], in fact it has been known

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for more than five decades [23], production of biodiesel from rejected cooking oil is also very common [6,11] but indeed it is now being taken seriously because of escalating price of petroleum and well associated global warming with burning fossil fuels [14]. Algal biodiesel is the best option to decrease the intensity of radiative forcing in order to reduce the effects of global warming caused by burning fossil fuels. The water requirement for algae culture is very high especially in open pond system, but fortunately their capability to grow in industrial, farm, municipal, and agricultural wastewater [28] resolves this problem as well as contributes in treatment of wastewater by decreasing the value of COD, BOD and removal of heavy metals, the treated wastewater can be use in other purposes such as irrigation. In 2007, World Mapper Projects [32,33] had calculated the water used in domestic purpose and in industries was 990 billion m^3 and after used water turns into wastewater polluting the environment. Another source of nutrients containing wastewater is from livestock or cattle industries. The major problem with most cattle wastewaters is the high concentrations of nutrients, particularly total N and total P concentration, which require costly chemical-based treatments to remove them during wastewater treatment [13]. Total N and P concentrations can be found at values of 10–100 mg L^{-1} in municipal wastewater, $>$1000 mg L^{-1} in agricultural effluent and 500–600 mg L^{-1} in farm wastewater [2]. The ability of microalgae to effectively grow in nutrient-rich environments and to efficiently consume nutrients and accumulate metals from the wastewater, make them an extremely attractive means for sustainable and low cost wastewater treatment [5,26,22].

However, it has also long been proposed that wastewater-grown algae could be used for energy production [3,35]. Wastewater treatment usually involves additional cost thus, if the treatment itself produces income, prevents pollution and complies with environmental standards, it increases the profitability and enhances the sustainability of the industry. According to Chinnasamy et al. [3] almost 500 billion m^3 industrial wastewater could produce 37 million t of algal oil, with variation due to the difference in nutrients composition in wastewater as well as difference in potentiality to accumulate lipid in algal strain. In this study the undertaken aims were to isolate the algal strains which were present in wastewaters sites and the strains were selected on the basis of lipid productivity via using Nile red fluorescence analysis to form consortium. The final objective of this study was to evaluate treated dairy farm (Perlis, Malaysia) wastewater for biodiesel production by cultivating consortium.

The dairy farm generated almost 182.5 million L wastewater $year^{-1}$ which are capable to produce 15,700 t biomass of algal consortium and ~3 million L algal oil $year^{-1}$.

2. Methods

2.1. Chemicals and reagents

Methylation catalysts, FAME standards, hexane and methanol were obtained from Sigma-Aldrich (Switzerland). All chemicals were analytical grade reagents.

2.2. Wastewater collection and analysis

The wastewater used in the study was collected from a moderate size commercial dairy farm located at Perlis, Malaysia and immediately stored at 4 °C to minimize substrate decomposition prior to analysis.

2.3. Isolation of microalgae from wastewater samples and their consortium

The untreated and treated wastewater samples were collected from the dairy farm wastewater collecting and holding tank sites Fig. 1. These samples were used as the sources of obtaining native algal strains. BG11 medium was used as for the enrichment of algal strains in wastewater prior to isolate them in different colonies. For strains enrichment, 50 mL of BG11 media were taken into 250 mL flask and added with 50 mL of treated and untreated wastewater sample in different flasks.