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Composition of fatty acid methyl ester in microalgae *Chlorella vulgaris*: Comparison between various methods of harvesting, extraction and transesterification

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ABSTRACT

The aim of the study was to identify which of methods produces the highest yield of fatty acid methyl ester (FAME) from microalgae. Different methods of harvesting (centrifugation, Cen & coagulation, Co), extraction (Test Tube, TT & Soxhlet, Sox) and transesterification (direct transesterification, d-trans & extraction transesterification, ext-trans) were considered. The procedures of this research consists of microalgae cultivation, harvesting of biomass and extraction of oil to obtain the lipid. The further process of converting lipid into FAME is followed by transesterification process. The FAME compositions of *Chlorella vulgaris* were analyzed using Gas chromatography mass spectrometry (GC–MS). The main components were consists of palmitic, stearic and oleic acids for both transesterification methods. However, FAME extracted from d-trans contained more components (linoleic and linolenic acid) than ext-trans. Furthermore, the highest amount of FAME gained by ext-trans was produced by the method of centrifugation-test tube (Cen-TT). Although Cen-TT produced the highest amount of FAME for ext-trans, it still cannot meet the highest amount of FAME produced by d-trans. Therefore, the Cen-TT method was selected to be the best microalgae harvesting and extraction method in ext-trans meanwhile the most efficient transesterification method was d-trans.

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1. Introduction

Biofuels are renewable energy source that can be used as a substitute for fossil fuels and have environmental benefits such as lower carbon dioxide emissions, resource depletion, and greenhouse gas emissions. Microalgae has been renounced as a renewable biofuel and can be produced by some processes like harvesting, extraction and transesterification method to gain biomass and to produce Fatty acid methyl ester (FAME). It can substitute fossil fuel because fossil fuel is fast depleting due to its extensive use especially by cars and factory.

Microalgae are a unicellular autotrophic species that are primarily photosynthetic, have been researched for their potential as alternative sources of animal feed, food supplements, and pharmaceuticals over the last few decades [1]. *Chlamydomonas reinhardtii*, *Dunaliella salina*, and various *Chlorella* species, as well as Botryococcus braunii are common species. *Phaeodactylum tricornutum, Thalassiosira pseudonana, Nannochloropsis*, and *Isochrysis* sp. are other essential algae groups [2]. *Chorella vulgaris* is a green alga discovered by a Dutch microbiologist, can be found in freshwater, aquatic, and terrestrial habitats, and it has a high photosynthetic capacity as well as the ability to growth quickly in autotrophic, mixotrophic, and heterotrophic environments [3].

Microalgae are among the most significant species in the Earth's ecological evolution and history. With a wide variety of promising technologies that address global challenges, they have the potential to influence our future. The global fossil fuel supply is depleting, and its life cycle has resulted in negative environmental consequences such as nitrogen dioxide (NO_2) which is released into the atmosphere when fossil fuels are burnt. Microalgae biomass is gaining popularity as a green and environmentally sustainable feedstock [4]. The process of harvesting has a huge effect on the reusability of recycled water because it affects the quality of

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