Abstract

[Project Information]

Project Title :	Elucidating the Effects of Polymer-Based Flocculants on Lipid Extraction from Microalgae
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[Abstract]

This study aims to investigate the effect of liquefied dimethyl ether (DME) as an extraction solvent on polymer-based flocculants (polymers) contained in microalgae, using a method for extracting oils and functional components without heat drying. Specifically, the study focuses on preventing the contamination of oils extracted from microalgae with DME by polymers, identifying the functional substances contained in the extract (Subtheme 1), and reducing the moisture content of microalgae aggregates recovered by flocculation and centrifugation to 80% or less while maintaining a microalgae recovery ratio of 98% or higher (Subtheme 2).

In Subtheme 1, we first estimated the Hansen solubility parameters for the polymer based on literature values and measured values, confirmed its insolubility in DME both theoretically and experimentally, and demonstrated that the polymer has minimal adverse effects on the extraction process.

Next, DME extraction experiments were conducted using chlorella aggregates, confirming that lipid extraction efficiency equivalent to the conventional chloroform/methanol method could be achieved. Additionally, the absence of polymer components in the extract was clarified through comprehensive instrumental analysis. Furthermore, it was demonstrated that simultaneous extraction of lipids and functional components is possible using DME for other algae as well. Furthermore, it was confirmed that when selecting polymers for these algae, it is necessary to consider the influence of the aggregate's moisture content and its impact on the extraction process.

In Subtheme 2, we first evaluated the basic characteristics of 25 polymers and six types of microalgae, and through flocculation experiments, identified at least one optimal polymer for each algae. Factors influencing flocculation effects were analyzed in detail, including the polymer

backbone, addition amount, stirring conditions, solution pH, and water temperature. Through multiple regression analysis, the primary factors influencing flocculation were identified, and conditions achieving a microalgae recovery ratio of 98% or higher were determined. Furthermore, for the effective utilization of extraction residues, the effectiveness of a two-liquid method using chitosan and sodium polyacrylate was demonstrated. Flocculation experiments using live microalgae were also conducted, confirming the high practicality of the process. Subsequently, the gravity concentration performance was evaluated for reducing energy consumption in the centrifugal dewatering process, achieving a moisture content of less than 80% for all algae.

Finally, based on energy calculations for the entire process considered in this study, which were derived from actual equipment conditions and experimental results, we demonstrated that this method is a promising bio-resource recovery technique with high energy efficiency.

[References]

Kanda, H. et al. (2024) 'Direct Extraction of Lipids, β-Carotene, and Polyphenolic Compounds from Wet Microalga *Dunaliella salina* by Liquefied Dimethyl Ether', Marine Drugs, 22(10),438. DOI: 10.3390/md22100438

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