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Study on Technology Development and Solvent Suitability for Separation of Essential Lipid from Various Bioresources: A Review

.

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Abstract:- The main objective of present study is the solvent suitability as an effective method for the separation of essential lipid from various bio resources. It is very clear from the literature survey that the solvent suitability can be achieved through different solvents such as hexane, methanol, ethyl acetate, liquid Co2. However there is a need to study more on the technology development for separation of essential lipid from bio resources. Hence, this review paper highlights the summary of Separation techniques and lipid extraction methods for removal of lipid from their bioresources.

Keywords:- *Extraction, Lipids, Micro algae, Macro algae.*

I. INTRODUCTION

The world energy demand has become a nationwide as well as a global issue and starts to raise serious problem in the form of renewable energy base to satisfy the futuristic demand [1]: now a day, majority of global fuel need is supplied by fossil-based fuels [2]. More use of these fossil fuels are creates serious problems in an energy shortage and impact on the environment [3, 4]. A plant has been familiarity as alternative raw material for biofuels such as bioethanol production [5, 6]. The *algal* biomass has become a future attractive source for biofuel production [7]. Algal lipids include polar lipids, which are ordinary structural includes phospholipids and glycolipids and neutral lipids [8, 9]. Microalgae are microscopic photosynthetic organisms such as roots, stems, and leaves of higher plants [10]. Macro algae contain the most essential components in the aquatic ecosystems, which are important for the marine bio resources preservation by preventing eutrophication and pollution [11]. Macro algae are generally fast growing and reach size up to 60m in length [12]. Prokaryotic and eukaryotic of photosynthetic microorganisms are found in unsuitable conditions due to their unicellular structure unit [13, 14].

II. MATERIALS AND METHODS

- *Pre-treatments of Algae biomass*

Pre-treatment can be applied on the biomass to increase lipid recovery efficiency through breaking the microalgal cell walls. This facilitates easier cellular lipid extraction. There were various methods can be used as pre-treatments such as mechanical, chemical, physical and biological.

- *Algae Cultivation:*

The cultivation methods of the microalgae production are commonly used in two ways: The open pond system and close photo bioreactors system. The open pond system was the earliest way to cultivate microalgae. The microalgae samples are put into an open pond with water. The open pond is designed as a paddle wheel to mix and cycle the algae cell. Which is operated in a circulatory mode, then the fresh input transformed towards the paddle wheel to the pond, and then the microalgae can be collected in the cyclic process. The close photo bioreactor system was a close environment to culture microalgae with technological equipment. There were various kinds of photo bioreactors such as Fermentation tank photo bioreactor, Tubular photo bioreactor, Plate photo bioreactor etc.

- *Harvesting:*

Harvesting lipid biomass was the separation of biomass from the culture medium. In which process 20-30 percent costs were measured through harvesting process. In some cases, costs percentage from 50 to 90%.

- *Centrifugation*

Centrifugation was a process for a composition mixture centrifuge to decant by centrifugal force. In centrifugation, gravity force was used for segregation at a much higher rate. Depending on segregation all kinds of micro algae can be segregated.

III. RESULTS AND DISCUSSION

- *Separation technique:*

The technology pathway was investigated the cultivation of algal biomass by lipid separation to hydrocarbon biofuels. Most of the researchers reported that the lipid extraction from microalgae methods such as physical and chemical methods. Solvent extraction was a most widely used technique with cell disruption techniques to increase the process for improvement yields. Different cell disruption methods were investigated such as autoclaving, osmotic shock, microwave-assisted extraction and sonication-assisted extraction. Table 1 shows the summary of separation techniques.

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Solvent type	Extraction conditions	Cell disruption	References
Hexanes: ethanol (subcritical co-solvent extraction)	Wet microalgae (– 90 °C, 1.4 MPa, 50min)	None	15
Methanol: chloroform	Freeze-dried microalgae(– 10 min grinding MP followed by stirring for 30 min and centrifugation for 10 min)	Lyophilization prior Mortar and pestle prior	16
ethyl acetate: methanol	Freeze-dried microalgae – 25 °C	Bead-beating and Lyophilization prior	17
Supercritical CO_2	Freeze-dried then re-wetted microalgae(- 60 min, 40 MPa, and 60 °C)	Lyophilization prior Drying under air prior	18
Liquid CO_2	Freeze-dried microalgae (– 120 min, 6.8 MPa, and 25 °C)	Lyophilization prior	19

Table 1:- Summary of separation techniques.

➢ *Lipid extraction:*

Microalgae lipid extraction was consist of harvesting and dewatering operations. Microalgae lipid stays in the microalgae cell after drying. The lipid extraction was to break the cell wall and cell membrane, then the lipid release from the microalgae cells. Microalgae lipid extracted from different methods as Chemical cool press method, Enzymatic Extraction and Supercritical Fluid Extraction. Table.2. shows the category of lipid extraction methods.

Extraction methods	Categories
Mechanical	Mechanical cell press, Grinding (with/without cryogens), high speed Homogenizers, Bead milling/bead beating.
Chemical	Solvent extractions, Supercritical fluid extraction, Ionic liquids, Osmosis, Oxidation.
Biological	Antibiotics, Enzymes (lytic, autolysis).
Electromagnetic	Microwaves (with/without solvents), Ultrasound.
Thermal	Freeze drying, Autoclave, Steam explosion, Hydrothermal liquefaction.

Table 2:- Category of lipid extraction methods.

➢ *Chemical Extraction.*

Chemical extraction methods were most commonly used organic solvents for extraction process. Chemical extraction was also known as solvent extraction. Solvent extraction was most widely used method for the extraction of oil and fats (lipids). Table.3. shows the summary of solvent extraction techniques.

Solvent	Cell disruption	Extraction conditions	References
1:1 (v/v) hexane: methanol	Grinded & Lyophilization prior	Freeze-dried microalgae for 120 min	[20]
3:1 (v:v) hexanes: ethanol (subcritical co-solvent extraction)	None	Wet microalgae for 50 min	[21]
2:1 (v:v) methanol: chloroform	Mortar and pestle	Freeze-dried microalgae For 10 min grinding	[22]
2:1 (v/v) chloroform: methanol	Grinded & Dried prior	Dried microalgae for 25 °C	[23]
2:1 (v:v) chloroform: methanol	Microwave	Wet microalgae For 5 min radiation (500 W)	[24]
1:2 (v/v) chloroform: methanol	Spray-dried prior	Dried microalgae For 25 °C	[25]
2:1 (v/v) dichloromethane: methanol	Ultrasonication and Microwave	Freeze-dried microalgae For 25 °C	[26]
2:1 (v:v) ethyl acetate: methanol	Bead-beating	Freeze-dried microalgae For 25 °C	[27]
1:1 (v:v) CF_3SO_3: methanol	Lyophilization prior	Freeze-dried microalgae For 65 °C	[28]

Table 3:- Summary of solvent extraction Techniques.

IV. CONCLUSION

The extraction of lipid from microalgae can be achieved by an expeller or press, solvent extraction with organic solvents, or supercritical fluid extraction (SCFE). Then after recovering the oil from microalgae, transesterification process is mostly adopted for synthesis of biodiesel. In this review clearly summarized the separation techniques, solvent extraction, and lipid extraction methods.

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