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Ultrasonication and Microwave Assisted Lipids Extraction Process (MALE) for Microalgal Biodiesel Production

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Mini Review

Energy needs

The world fuel demand is mainly supplied by fossil-based fuels [1]. Over exploitation and use of fossil fuels raised serious issues, energy shortage and their detrimental effects on the environment. To overcome these problems there is immense need to replace fossil by renewable energy sources [2,3]. Biomass (organic materials) provides an effective alternate energy source for the production of biofuels (biogas, bioethanol, biodiesel) [4-6]. Among these biodiesel is considered as one of the promising alternative fuel for diesel engines due its renewability and environment friendly nature [7]. Biodiesel can be produced from food crops, edible, non-edible vegetable oils (from soybeans or oil palm), macro and microalgae and aquatic weeds [8,9]. However, the use of food crop for energy production is in competition with food consumption and limited availability of agricultural land. Microalgal lipid emerged as potential source for biodiesel compared to other bioresources [7]. It has no competition with food crop or arable land. Further it has the advantage of adaptability to different environments, high biomass accumulation and lipid yield up to 80% of the dry mass [10].

Microalgal lipids are used as feed stock for biodiesel production and are derived from oleaginous microalgae [11,12]. For efficient utilization of microalgae for biodiesel production it is important to employ effective and reliable methods for lipid extraction from the microalgal biomass [13]. The production process involves several stages such microalgae cultivation, biomass harvest, treatment and lipid extraction, finally biodiesel synthesis. Ultrasound and microwave techniques are used for lipid extraction. Both physical and chemical process are employed for effective lipids recovery from microalgal biomass and it conversion into biodiesel [14]. Microwave assisted processes are more effective than ultrasound techniques. Different processes.

Ultrasonication for cells disruption

Ultrasound is an effective method for microalgae cells disruption at lower temperatures as compared with autoclave, thermal and microwave methods. It is preferred as it does not require any addition of chemicals or a bead, therefore processing costs is lower in this method. Based on the suitability it is an effective method for homogenization and cells lysis in aqueous phase [15]. During the process of ultrasonication the sonic waves are generated and transferred to microalgal intact cells. These waves are strong enough for multiple productions of microbubbles in nucleation points in the liquid medium. These waves create a series of microbubbles (cavitation phenomenon), which then burst and release kinetic energy to the cellular surface and finally the cell wall becomes ruptured and lipids are then released off the cell to the exocellular medium [16].

During the rarefying phase of the sonic waves the microbubbles grow and then collapse in compression phase. When they collapse in strong shock waves they pass through liquid medium. The whole process of microbubbles formation, rarefying and compression is called cavitation. The collapse of these bubbles converts the sonic energy into mechanical energy that is about to 300MPa which is equivalent to several thousand atmospheric pressure. This imparts enough energy for lysis that exceed from the mechanical strength of cell wall. A second factor called shear stress caused by high velocity gradient and vibrating bubbles in ultrasonic process, also increase the extent of cell lysis [17]. Gerde and his team have investigated the effect of ultrasonic waves on the cellular integrity and lipids recovery from heterotrophic and autotrophic microalgae i.e. *Schizochytrium limacinum* and *Chlamydomonas reinhardtii* respectively [18]. Cell disruption efficiency was determined by the release of intracellular materials lipids were stained by Nile red fluorescence. Maximum cell disruption was achieved at energy input of 800J/10mL Gerde & Araujo [18] have reported five methods of lipids extraction from *Chlorella vulgaris* in combination with ultrasonication [18,19]. The results were quite promising and in first method they have recovered 52.5% (wt/wt) lipids without addition of silica. According to their findings, ultrasonication was effective for extracting lipids in integration with Bligh and Dyer method [19].

Microwave assisted lipids extraction process (MALE)

Microwave heating is caused by the ability of the materials to absorb microwave energy and convert it to heat. There are different factors which affect the effectiveness of microwave assisted lipids extraction process (MALE) for cell lysis and lipids extraction i.e. microwave power, temperature, treatment time, input energy consumption (kJ), solid–liquid ratio, dielectric properties, and the nature and concentration of organic solvent used for lipids extraction [20]. The mechanism for microalgal cell disruption by microwave process could be explained based on nature of microwaves and substances present in the substrate (biomass). Microwave heating of substances (biomass) occurs due to dipolar and ionic mechanisms. When substrate is subjected to electromagnetic waves (microwave) the presence of moisture or water causes dielectric heating due to dipolar nature of water. Interaction between compounds and incoming microwaves moisture or water. The permanently polarized dipolar molecules try to realign in the direction of electric field in the oscillating electric field incident on water molecules [21]. At high frequencies (MHz-GHz) the intra-molecular friction caused by the oscillations/vibrations of polar molecules raises the number of charged ions result a rapid heating within fraction of seconds in substrate compounds. Subsequent heating in intracellular matrix result in the rupture of cell membrane and release of cellular contents [22].

According to the findings of Balasubramanian et al. [22] a continuous microwave process could potentially be used for microalgal cells disruption and lipids extraction. According to their results and findings 77% (wt/wt) lipids recovery was achieved at higher microwave frequencies and temperature at 95 C for 30 minutes from *Scenedesmus obliquus*. Temperature and contact time were the main factors influencing the lipids yield. From lipids analysis, the presence of unsaturated fatty acids confirmed the suitability if microwave process for biodiesel synthesis. Based on their results it is suggested that microwave process is equally effective for a number of microalgae strains to extract lipids for biofuels synthesis [22]. According to the research findings from fractal characterization and dynamic microstructures of cell wall disruption, the microwave processing of wet microalgae biomass was found to effective for lipids extraction in aqueous phase. In another study the effectiveness and efficiency of microwave processing for lipids extraction from wet biomass of *Chlorella Py-Zu1*, have been investigated Cheng et al. [23]. They have used microwave frequency at higher temperature (80-120 °C) for 20 to 26 minutes which caused an increased cell fractal dimensions. About 19% (wt/wt) lipids recovery was achieved in wet phase as compared to conventional method (20% recovery). The content of free fatty acids was increased from 88.65% to 91.95% due to molecular bond vibrations, electromagnetic effect and breakage by heat which result the fragmentation of high molecular weight fatty acids [23]. However biofuels are not yet commercially competetive with fossil fuels.

References

1. Demirbas A, Demirbas F (2011) Importance of algae oil as a source of biodiesel. Energy Conversion and Management 53(1): 163-170.
2. Veljkovic VB, Stamenkovic OS, Tasic MB (2014) The wastewater treatment in the biodiesel production with alkali-catalyzed transesterification. Renewable and Sustainable Energy Reviews 32: 40-60.
3. Yaakob Z, Narayanan BN, Padikkaparambil S, Unni SK, Akbar MP (2014) A review on the oxidation stability of biodiesel. Renewable and Sustainable Energy Reviews 35: 136-153.
4. Chisti Y (2007) Biodiesel from Microalgae. Biotechnology Advances 25: 294-306.
5. Raja I A, Wazir S (2017) Biogas Production: The Fundamental Process, Universal Journal of Engineering Science 5 (2), 29-37
6. Qv XY, Zhou QF, Jiang JG (2014) Ultrasound-enhanced and microwave-assisted extraction of lipid from Dunaliella tertiolecta and fatty acid profile analysis. J Sep Sci: 37(20): 2991-2999.
7. Khan SA, Rashmi Hussain MZ, Prasad S, Banerjee UC (2009) Prospects of biodiesel production from microalgae in India Renew. Sustain. Energy Rev 13(9): 2361-2372
8. Jones CS, Mayfield SP (2012) Algae biofuels: versatility for the future of bioenergy. Curr Opin Biotechnol 23(3): 346-351.
9. Mubarak M, Shaija A, Suchithra TV (2016) Ultrasonication: An effective pre-treatment method for extracting lipid from *Salvinia molesta* for biodiesel production. Resource efficent technologies 2(3): 126-132.
10. Chisti Y (2008) Biodiesel from microalgae beats bioethanol. Trends Biotechnol 26(3): 126-131.
11. Shah SH, Raja IA, Mahmood Q, Pervez A (2016) Improvement in lipids extraction processes for biodiesel production from wet microalgal pellets grown on diammonium phosphate and sodium bicarbonate combinations. Bioresour Technol 214: 199-209.
12. Shah SH, Raja IA, Rizwan M, Rashid N, Mahmood Q, et al. (2018) Potential of microalgal biodiesel production and its sustainability perspectives in Pakistan. Renewable and Sustainable Energy Reviews 81(Part 1): 76-92.
13. Mercer P, Armenta RE (2011) Developments in oil extraction from microalgae. European Journal of Lipid Science and Technology 113: 539-547.
14. Daroch M, Geng S, Wang G (2013) Recent advances in liquid biofuel production from algal feedstocks. Applied Energy 102: 1371-1381.
15. González-Fernández C, Sialve B, Bernet N, Steyer JP (2012) Thermal pretreatment to improve methane production of Scenedesmus biomass. Biomass and Bioenergy 40: 105-111.
16. Jeon BH, Choi JA, Kim HC, Hwang JH, Abou-Shanab RA (2013) Ultrasonic disintegration of microalgal biomass and consequent improvement of bioaccessibility/bioavailability in microbial fermentation. Biotechnology for biofuels 6(1): 37.

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17. Fichtali J, Senanayake SN (2010) 10 Development and commercialization of microalgae-based functional lipids. Functional food product development 2: 206.

18. Gerde JA, Montalbo-Lomboy M, Yao L, Grewell D, Wang T (2012) Evaluation of microalgae cell disruption by ultrasonic treatment. Bioresource Technology 125(0): 175-181.

19. Araujo GS, Matos LJBL, Fernandes JO, Cartaxo SJM, Gonçalves LRB, et al. (2013) Extraction of lipids from microalgae by ultrasound application: Prospection of the optimal extraction method. Ultrasonics Sonochemistry 20(1): 95-98.

20. Ali M, Watson IA (2015) Microwave treatment of wet algal paste for enhanced solvent extraction of lipids for biodiesel production. Renewable Energy 76: 470-477.

21. Chemat F (2009) Essential oils and aromas: Green extractions and Applications, Dehradun: HKB Publishers, India.

22. Balasubramanian S, Allen JD, Kanitkar A, Boldor D (2011) Oil extraction from *Scenedesmus obliquus* using a continuous microwave system-design, optimization, and quality characterization. Bioresource Technology 102(3): 3396-3403.

23. Cheng J, Sun J, Huang Y, Feng J, Zhou J, et al. (2013) Dynamic microstructures and fractal characterization of cell wall disruption for microwave irradiation-assisted lipid extraction from wet microalgae. Bioresource Technology 150: 67-72.

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