DOWNSTREAM PROCESSING OF MICROALGAE UTILIZING PULSED ELECTRIC FIELDS (PEF)

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Summary

Fast growing, diverse and with flexible outputs, microalgae have attracted considerable research interest. Recognized as prime candidates for 3rd generation biofuels, mainly due to their ability to be cultivated on non-arable land and their high lipid content (up to 50% of dry weight for some strains), they have also been considered for a number of bio-technological applications such as aqua-feed industry and high value dietary supplements.

The main challenges for lipid extraction from microalgae is the selection of the appropriate set of chemical solvents and the strong, rigid cell walls that surrounded them. Microalgal lipids can be either polar or neutral and lipids generally dissolve in a solvent of similar polarity meaning a mixture of co-solvents for total lipid extraction is usually required. As for the presence of cell walls, a pre-treatment process is necessary. Said processes, either physical, chemical or biological in nature, should be mild, economic and not harmful to the targeted product. Pulsed Electric Fields (PEF) have been successfully demonstrated as one such microalgae pre-treatment method. During PEF, the cells are subjected to an external intense electric field for very short periods of time leading to an increase of the transmembrane potential of the cell membrane. As a result, the permeability of the cell membrane is increased and the exchange between intracellular components and an external solvent is greatly enhanced.

In the Bio-electrics group of the Institute for Pulsed Power and Microwave Technology (IHM) in the Karlsruhe Institute of Technology (KIT) we have successfully demonstrated the complete permeabilization of the lipid-rich microalgae strain *Auxenochlorella Protothecoides* (AP) after PEF-treatment along the spontaneous release of various intracellular carbohydrates and other water-soluble components. The microalgae biomass is then further mixed with Ethanol:Hexane (1:0.41 vol/vol), two common industrial solvents, and almost total lipid extraction is achieved (90% of total lipids as determined with other reference methods). The above results can be further enhanced and the PEF treatment energy greatly reduced (from 150kJ/kg_{susp} down to 25kJ/kg_{susp}) with the introduction of an incubation step of the pulsed biomass, ranging between 2-24hrs at inert conditions showing that even in low energies PEF initiates a number of complex biological processes that influence the extraction.

Gas chromatography analysis of Fatty Acid Methyl Ester (FAMEs) produced from transesterified lipids indicate that AP, especially at mixotrophic conditions, has a fatty acid profile mainly composed of C16-C18 fatty acids including large amounts of mono-unsaturared C18:1 making it thus a good candidate for biodiesel production. PEF has no effect neither on the FAME composition compared to reference methods nor on the overall mechanical structure of the cell as determined by microscopy. Future works are on further illuminating the PEF mechanism and the more selective extraction of different microalgal components such as carotenoids.

Literature

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