Abstract

Renewable bioenergy derived from various biomass feedstocks holds promising potential, as they are obtained either as wastes or as by-products of agro-food industries, whose disposal would otherwise become additional burden to industries and pose environmental hazards. In recent years, microbial biomass takes a significant share in the bio-energy sector, as they are capable of producing fuel sources either in the form of readily usable alcohols or as stored- fats at higher productivity, which can then be converted to ester-fuels through transesterification process. In efforts to minimize the gap in bio-manufacturing economics and to increase the commercial potential of biomass based fuels, the current research endeavours are more focussed towards production of multiple products from biomass. In this context, the present thesis aims towards achieving an economically viable biofuel production process from an oleaginous yeast isolate, *Meyerozyma caribbica*, by conducting systematic process optimization studies to improve biomass yield and lipid accumulation. Further it attempts to develop an integrated process for biodiesel production, by combining erstwhile standalone processes namely, lipid extraction and transesterification into a single step, thus minimizing processing cost and energy requirement. Also as a holistic measure to augment the cost viability in biofuel production, the present thesis additionally investigates the valorisation potential of de-oiled biomass recovered after transesterification by converting it to energy-intense bio-crude through hydrothermal liquefaction (HTL) process. Finally, it presents an overall environmental impact assessment of biodiesel and bio-crude production process by a detailed life cycle analysis (LCA). Initial upstream optimizing studies to assess the influence of nitrogen limitation and oxygen transfer over lipid accumulation resulted in a maximal lipid concentration of 10.8 ± 0.5 g/L at initial C:N ratio of 60:1 and k_La of 0.8 min^{-1} in shake flask. The sonication-assisted direct transesterification of yeast biomass, using methanol-hexane as solvent system, under optimal conditions of biomass/methanol ratio of 1:20 w/v, time - 6 h, temperature - 60 ℃ and catalyst concentration - 4 % w/v, resulted in 92 % fatty acid methyl ester (FAME) yield (%w/w of lipid). The biodiesel properties computed from FAME profile showed their compliance with international standards. In biomass valorization study using HTL process, glycerol supplementation improved the bio-crude yield up to 50 ± 1 wt% with a calorific value of 32 MJ/kg. Comprehensive LCA for the entire study suggested that direct-transesterification and HTL steps required further improvement in terms of energy and solvent consumptions. Thus the current thesis demonstrates the impending potential of yeasts-based biomass feedstock as the sustainable source for bioenergy generation by production of biodiesel and bio-crude through systematic process optimization and integration studies.

Keywords: Bioreactor; Cell disruption; Co-solvent; Direct transesterification; Energy balance; Fatty acid methyl esters; Glycerol; Hydrothermal liquefaction; Lipid; Nitrogen limitation; Oxygen saturation