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Cost Effective γ- linolenic Acid from Microalgae through Biorefinery Approach

Sourish Bhattacharya* and Sandhya Mishra

CSIR-Central Salt and Marine Chemicals Research Institute, Bhavnagar, Gujarat, India

*Corresponding author: sourishb@csmcri.res.in

Abstract

Background and Objective: One of the major challenges related with the algal biofuel production in a biorefinery approach is improving biomass utilization for net energy gain providing economically viable and scalable process for deriving commercially important co-products through a greener route. A novel integrated process based on detergent (sodium dodecyl sulphate) based hydrolysis to convert the carbohydrates present in microalgal biomass to reducing sugars for microbial fermentation, while making available lipids for downstream processing of γ- linolenic acid, leaving protein rich fragment behind.

Methods: The microalgal cultivation of *Chlorella variabilis* was carried out during the peak summer season (June 2016) in Gujarat, India with a 46±3°C ambient air temperature. A cell concentration of 2g/l (wet basis) was used to inoculate the tank with an area of 1.2 m^2. The total lipid content was quantified gravimetrically from the sun-dried biomass as per Bligh & Dyer, 1959. The obtained total lipids are subjected to fractionation with urea followed by transesterification of obtained poly-unsaturated fatty acids. γ- linolenic acid was extracted and purified from total polyunsaturated fatty acids through argented silica gel chromatography as per Guil-Guerrero *et al.* 2000. Further, hydrolysis of the spent biomass was done using 1% (w/v), 3% (w/v) and 5% (w/v) sodium dodecyl sulphate (SDS) at 120 rpm for 12 h at ambient temperature for obtaining reducing sugars. *Bacillus licheniformis*, a marine bacterium isolated from CSIR-CSMCRI's experimental salt farm, Gujarat, India was used for the production of ε-polylysine utilizing microalgal hydrolysate prepared from the spent biomass of *Chlorella variabilis*. The crude extract ε-PL extract obtained after ammonium sulphate precipitation was subjected to lyophilisation for obtaining dry powder containing ε-PL. Further, the dried material containing ε-PL was completely dissolved in 10 ml EAN at 60 °C and kept immediately at -20 °C for 4 h for precipitation of ε-PL. Finally, the ionic liquid (EAN) may be decanted and the precipitate will be dried for obtaining pure ε-PL.

Results: In the current context, textile effluent was supplementing the carbon and nitrogen source for the growth of *Chlorella variabilis*. From 495 gm. of microalgal biomass, 109.4 gm total lipids can be extracted containing 34.65 gm. γ-linolenic acid. After lipid extraction, SDS mediated hydrolysis of spent microalgal biomass yielded 36.68 gm. of reducing sugars and protein rich biomass was left containing 9.65gm. total proteins. Further, microbial fermentation using obtained hydrolysate containing 36.68 gm fermentable sugars along with medium components was carried for 1.3 gm pure ε-polylysine.

Conclusion: One of the major environmental issues with the textile industry sector is the disposal of their effluent containing unreacted dyes and high concentration of salt. Most of the textile effluents consist of high concentration of bicarbonate salts which is an important substrate for the growth of *Chlorella* sp. In the present study, *Chlorella variabilis* was grown in open tanks at a scale of 100L using 40% textile effluent for generating microalgal biomass containing γ-linolenic acid which is an important nutraceutical and generally added into the cooking oil's. A total of 495 gm. microalgal biomass was generated containing 34.65 gm. γ- linolenic acid. Further, 36.68 gm. of fermentable sugars was extracted from the deoiled microalgal biomass for preparing 1.3 gm ε-polylysine which has various biomedical applications in pharmaceutical sector.

Keywords: Biofuel, *Chlorella variabilis,* microalgal biomass, lipid