Recent Advances in Microalgal Biotechnology

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Chapter: Industrial Production of Microalgal Cell-Mass and Bioactive Constituents from Green Microalga-\textit{Botryococcus braunii}

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Industrial Production of Microalgal Cell-Mass and Bioactive Constituents from Green Microalga-Botryococcus braunii

Abstract

The world is facing lack of alternative fuels. The demand for alternate energy is increasing every day and concurrently the depletion of fossil fuels has been so rapid that it could lead to energy crisis in the future. The energy production from photosynthetic microorganisms such as algae is the solution to this issue, which is providing an eco-friendly alternative to meet energy requirements. Microalgae are potential source of nutrients and health promoting substances, as well as high valuable metabolites that are unique and of high commercial use. In this context, we selected microalgae Botryococcus braunii for the biofuel production, which contain 70% hydrocarbons in the biomass on the dry weight basis, and also it accumulates other bioactive compounds such as ether lipids, fatty acids, exo-polysaccharides and carotenoids, which are having high industrial applications. Our recent published results and also current literature on the effect of various culture conditions on biomass, hydrocarbon, lipids and fatty acid production in B. braunii, cultivation of B. braunii in raceway ponds and photobioreactors, downstream processing of hydrocarbons, bioactive molecules and their use in various applications, biological activities of B. braunii extracts with special reference to carotenoids were added to this book chapter. This chapter covers up to date information on the culture conditions, cultivation methods, biomass production, hydrocarbons, chemicals, bioactive constituents and their biological properties, downstream processing of hydrocarbons from B. braunii.

Keywords: Bioactive compounds; Biomass; Botryococcus braunii; Hydrocarbons; Lipids; Photobioreactors; Raceway ponds

Introduction

Botryococcus braunii is a unicellular photosynthetic microalgae, member of the chlorophyceae (chlorophyta). It is producing large amounts of biomass, lipids, hydrocarbons and other bioactive molecules which can be used in renewable fuel. B. braunii is widespread in freshwaters, brackish lakes, reservoirs and ponds [1-3]. It is identified in several countries such as USA, Portugal, France, India, Japan, Philippines, Malaysia, and Thailand etc based on their geographical regions. The rRNA (16S RNA) sequence of B. braunii is compared with other algae species Chara acetabulum and Dunaliella parva and found to be very close [4]. B. braunii is known to accumulate more hydrocarbons under various culture conditions [5-8]. It is divided into three different races-A, B and L based on the characteristics of hydrocarbons they produce. The race-A produces n-alkadienes and trienes (C_{16}-C_{20}), race-B produces botryococenes (C_{18}-C_{20}) and race L produces tetraterpenes (C_{20}) [3,9,10]. B. braunii also synthesizes lipids-fatty acids, triacylglycerol, and sterols [11]. Apart from hydrocarbons, B. braunii produces other bioactive molecules such as exo-polysaccharides and carotenoids [12,13]. Biomass, lipid and hydrocarbon content varied based on the culture conditions [5-8,12]. Hydrocarbons produced distillate fractionates-gasoline (67%), aviation (15%), diesel fraction (15%) and remaining residual oil by hydrocracking [9]. These fuels are reported to be free from nitrogen and sulfur oxides after combustion. Owing to its lipid and hydrocarbon production, these microalgae are recognized for the renewable fuel [14]. Hydrocarbons and lipids are improved by supplying carbon-dioxide [8]. Further, research studies will be required on to improve the optimal culture conditions for the hydrocarbon and lipid production in B. braunii. The present book chapter is covered on the biomass, hydrocarbon and lipid production from B. braunii under various culture conditions, cultivation of B. braunii in raceway and photobioreactors, hydrocarbon extraction, bioactive constituents and their use in industrial applications, and also special attention to be paid to biological properties of B. braunii.