

Botryococcus braunii - A potential source of high value chemicals

High value biochemicals, including lipid, protein, polysaccharide, and carotenoid, etc. are gaining significant attention in energy development and waste resource utilization. Among a variety of high-value feedstocks, microalgae are particularly promising because of their high value biochemicals and the ability to capture CO₂ through photosynthesis. *Botryococcus braunii*, which are photosynthetic cell factories, possess unique capability to synthesize chemicals that have promising potential as feedstocks for biofuels, pharmaceuticals, nutraceuticals, and materials production. *B. braunii* is grouped into three different races “A”, “B”, and “L” depending on the type of hydrocarbons it synthesizes. Race A *B. braunii* accumulate n-alkadiene and n-alkatriene hydrocarbons with an odd number of carbons from C₂₃ to C₃₃. Race B produce triterpenoid hydrocarbons, C₃₀-C₃₇, botryococcenes, and methylsqualenes. Race L produce a tetraterpenoid hydrocarbon, lycopadiene.

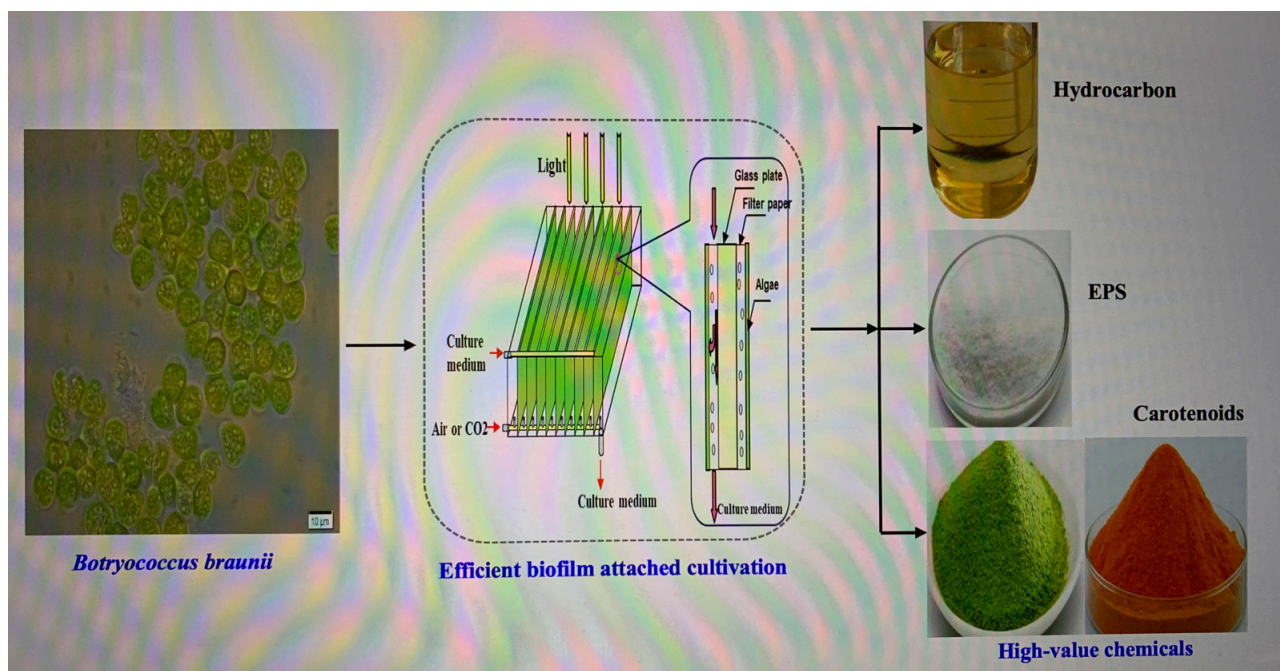


Fig. 1. Efficient cultivation of *Botryococcus braunii* and wide application of its high value chemicals.

Thus far, most of the research on *B. braunii* has focused on the biosynthesis of hydrocarbons and lipids, culture methods and conditions, and downstream processing of the hydrocarbons. However, *B. braunii* cell densities in traditional open ponds or enclosed photobioreactors are typically low, and not cost-effective on a commercial scale for mass cultivation for hydrocarbon production. As an alternative to suspension-based culture systems, a novel culture method has been developed, i.e.,

the “biofilm attached culture”. The biofilm attached system has a particular advantage in reducing the costs related to algae harvesting and offers unique features of minimizing the limitation of light penetration and enhancing CO₂ mass transfer.

Regarding high value chemicals, triterpenes from race B are thought to be the most promising source of biofuels and medicinal compounds, among different types of hydrocarbons. Botryococenes and methylsqualenes are branched hydrocarbons from race B, which can be processed into jet fuels with high heating values. It is desirable to keep oils produced from rice B in the form of free extracellular hydrocarbons, such as botryococenes or methylsqualenes by avoiding contact with oxygen. Moreover, squalene, can accumulate in cholesterol auxotrophic lymphomas, and can change the lipid structure of cells. Thus, it can affect cells death of iron chain cells and offer an advantage in oxidative stress and tumor xenotransplantation. Interestingly, the existence of *B. braunii* in the geologic past is notable, as evidenced by the presence of botryococene derivatives in petroleum sediments.

Besides secreting hydrocarbons, *B. braunii* is also well known for synthesizing large amounts of exopolysaccharide (EPS). EPS is rich in galactose and fucose, contains glucuronic and galacturonic acids, and could also be used in the chemical industry for polyester production. EPS has a notable potential for the synthesis of nanoparticles. Also, *B. braunii* is a rich source of idea carotenoids, especially the unique secondary uncharacterized carotenoids such as botryoxanthins and braunixanthins that have never been found from other microalgae.

Botryococcus braunii accumulates and stores large quantities of hydrocarbons in its extracellular space rather than in its cytoplasm during at least two different growth stages within the cells, which makes their extraction more economical and convenient. Cells of these microalgae are connected by large amounts of extracellular biopolymers, containing hydrocarbons at the basolateral region and enclosed by a retaining wall, from which polysaccharide fibrils extend to construct a colony sheath. There is clearly more opportunity to utilize the *B. braunii* biomass for high-value chemicals production, due to its unique metabolic pathways, ability to adapt physiologically, and its ability to grow well in the unique attached culture systems (Fig. 1).

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