Chapter 12
Macroalgae-Based Bioethanol

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ABSTRACT

The chapter discusses the methods effective for the extraction of useful energy from the macroalgae biomass including liquefaction, anaerobic digestion, fermentation to biobutanol, trans-esterification to biodiesel, pyrolysis, direct combustion, fermentation to bioethanol, and gasification. However, if the algae are suited for the production of biodiesel, they can be studied from the content of their triacylglycerols (TAGs). Due to having high fatty acid content, they have a high conversion rate to biodiesel, and the lack of sulphur, phosphorus, and nitrogen also aids in the conversion. This chapter highlights the limitations and suitability of macroalgae for the conversion process in reference to chemical composition, process optimization, and cost effectiveness. It is concluded that bio-oils and bioethanol produced from wet macroalgae are considered over biodiesel production because of high lipid content of microalgae biomass. Moreover, the chapter considers electricity production from the dry mass as it would turn profitable, and this can be achieved from fast-growing macroalgae like "Ulva."

INTRODUCTION

Fossil fuel hydrocarbons are being overly used which results in their scarcity and being expensive. The focus of research on converting biomass to biofuels has shifted to third-generation biomass, such as algae. The first-generation feedstock is divisive due to the food-fuel conflict, whereas the high-cost lignin removal technique limits the second-generation biomass (A Bayu, 2018). As algae can repair greenhouse gases (CO2) through photosynthesis, it is a promising renewable energy source. The typical photosynthetic productivity of marine biomass is 6–8%, which is significantly greater than the 1.8–2.2% of terrestrial

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biomass (Adams, J.M., 2009 & Junying, 2015). Marine macroalgae are the source of aquatic biomass which shows significant opportunities to become renewable energy sources. Aquatic biomass has 6–8% of photosynthetic efficiency, which is significantly greater than terrestrial biomass (1.8–2.2%). For the conversion of solar energy and production of biofuels, either marine macroalgae such as seaweed or microalgae might be employed (Hirano, A, 1997).

Macroalgae are large, fast-growing marine and freshwater plants with a maximum length of 60 metres. Due to the lack of water limitations, the marine macroalgae growth rates outpace the growth rate of terrestrial biomass (K. Sudhakar, 2018). The principal marine macroalgae have higher yearly production rates (grams C m2 yr1) than most terrestrial biomass. Phytocolloids like agar, alginates (derived from Phaeophyta) and carrageenan (derived from Rhodophyta), are mostly generated from seaweeds. The by-products of such processing can likewise be used as a renewable energy source (Kawai, 2016 & Notoya, M., 2010). Macroalgae are primarily of three kinds green (Phaeophyta), Red (Rhodophyta) and brown (Phaeophyta) depending upon their photosynthetic pigmentation differences (Chlorophyta). Red has the most species (6000), green (4500), and brown (2000) (Inn Shi Tan, 2020; Mohsen Ghadiryanfar, 2016). Red algae grow in the intertropical zones while the brown algae thrive in temperate to cold or extremely cold seas. Green algae may be found in a range of aquatic environments. In Asia, macroalgae are now farmed for food, fertilisers, and hydrocolloid extraction, (72%) majority-owned by Japan, Korea, Philippines and China worldwide yearly output. Macroalgae productivity varies from 150 to 600 t per hectare per year in fresh weight, with a total global production of 12 million tonnes of dry matter per year (Ashok Pandey, 2011; Huihui Chen, 2015). The extraction from macroalgae biomass of biofuels, on the other hand, received not much attention. Hydrocolloid extraction is presently the only significant industrial product derived from macroalgae. However, macro-algae may be used to extract a variety of high-value speciality goods.

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