Chapter 11
Recent Advancements in Microalgae-Biofuel Generation Employing Nano-Additives

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ABSTRACT

Biofuels have gained significant interest as an alternative fuel in recent years owing to their environmental sustainability, cost-effectiveness, and the ability to blend with traditional fuels like gasoline without requiring engine modifications. The use of microalgae for biofuel production is universally preferred due to its energy efficiency and environmental sustainability; current research is geared towards enhancing the production of microalgae-biofuel from the initial stages to the final product as it is a cost-effective fuel option. The use of different types of nano-additives at different stages of microalgae cultivation and incorporation into biofuel produced noteworthy improvements in the final product. This chapter focuses on the prospective uses of nano-additives in microalgae cultivation, microalgal biomass conversion to biofuels, and biofuel combustion improvement for revolutionary advancements in biofuel technology.

INTRODUCTION

Photosynthetic microorganisms like green microalgae, diatoms, and cyanobacteria offer significant advantages over terrestrial plants providing an abundance of various biomolecules to be used for food, feed, and fuel applications. Microalgae or microphytes are microscopic algae. They are naturally found in freshwater bodies and oceans. Microalgae are unicellular species that can exist individually or in

DOI: 10.4018/978-1-6684-5269-1.ch011

chains or groups. Microalgae can vary in size depending on the species, from a few micrometers (μm) to a few hundred micrometers. Microalgae are efficient photosynthesizers and are crucial for life on earth producing around half of the atmospheric oxygen it also performs its role as a photoautotroph consuming greenhouse gases like carbon dioxide to grow. Forming the base of the food web Microalgae and bacteria provide energy for all the trophic levels above them (Peter *et al.,* 2021). There exists a rich biodiversity of microalgae which represents an abundant, almost untapped resource. There are about 200,000-800,000 species in different genera of microalgae of which about 50,000 species are characterized and described. More than 15,000 novel compounds originating from algal biomass have been identified including carotenoids, antioxidants, fatty acids, enzymes, polymers, peptides, toxins, and sterols.

Microalgae form an abundance of carbon-rich biomass, that can be tapped for the production of biofuels, cosmetics, health supplements, and pharmaceuticals. They also have numerous applications in wastewater treatment and sequestration of atmospheric CO2. A wide range of bioproducts, including polysaccharides, lipids, pigments, bioactive compounds, proteins, vitamins, and antioxidants are also derived from microalgae. There is a rapidly growing interest in the use of microalgae as a renewable and sustainable feedstock for biofuels production fueling new research in the field of biorefinery using microalgae. The cultivation of microalgae on an industrial scale to produce biofuels and bioproducts has increased radically in the last couple of decades (Low *et al.,* 2021).

Figure 1. Different biofuels from microalgae and conversion processes
(Hossain et al, 2009)