Biomass and Bioenergy Solutions for Climate Change Mitigation and Sustainability

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Growing awareness and an increased focus on environmental issues such as climate change, energy use, and loss of non-renewable resources have brought about a greater need for research that provides potential solutions to these problems. Research in environmental science and engineering continues to play a vital role in uncovering new opportunities for a "green" future.

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grow. There are microalgae and macroalgae (e.g., seaweed) that grow in saline and hypersaline water. This chapter presents the promising potential of algae (microalgae and macroalgae) as a superfood.

Chapter 9

The steep rise in human population together with the simultaneous growth of urbanization and industrialization has triggered overuse of fossil fuels in the recent years. However, they are non-renewable and release carbon dioxide causing global warming. In this context, biofuels come as excellent substitutes because they are renewable and eco-friendly. They are obtained from biological products and include biodiesel, biomethane, bioethanol, and biohydrogen. They are classified into first, second, and third generation fuels depending on the biological feedstocks being used. Of these, the third-generation fuels, obtained from marine resources like algae, have attracted special research interests because they do not rival the food crop production or depend on land and freshwater for their cultivation. However, the potentialities of macroalgae as a biofuel resource have not been investigated thoroughly. The chapter tries to outline all the aspects of biofuel production from macroalgae pointing out the scopes for future research.

Chapter 10

Natural gas hydrate (NGH) has emerged as a future source of energy for the world that can fulfill the future energy demand. The natural gas hydrates hold twice the amount of energy than all available fossil fuels. At present, the energy demand is growing, but these are not available commercially. Various field applications on the dissociation of the natural gas hydrates have been performed till now, and the output of these field applications confirms the possibility of dissociation of the natural gas hydrates. At distinct locations in the world, the huge deposits of hydrates have been identified, but the safe and economic dissociation of gas hydrates is not known yet. Hence, the evolution of new and inexpensive, suitable methods and technologies are required for the dissociation of gas hydrates. In this chapter, the authors reviewed several articles to compare the different dissociation techniques of gas hydrates and their field applications. The advantages and disadvantages of these production methods have also been discussed.

Chapter 11

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.

Chapter 12

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."

Chapter 13

Development of sustainable energy resources is a major concern in front of the scientific community and stakeholders in this field. Invariably, fossil fuels are utilized to meet the major part of energy demand all over the world, but their stocks are limited. Burning of fossil fuels also causes significant environmental pollution that results in drastic climate change. There is an emergent need of an alternative to fulfill the current energy demand in a sustainable way along with sorting out the pollution issues. Microbial biofuels could be the most appropriate choice in this regard because it bears enormous potential that needs to be exploited. But it has some challenging issues to employ it to meet out the current energy demands. This chapter illustrates the microbial biofuels, harvesting techniques, different process, and potential to utilize them as sustainable energy sources along with considerable challenges that need to be addressed

Chapter 9
Biofuels From Macroalgae: A Sustainable Alternative to Conventional Energy Resources

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ABSTRACT

The steep rise in human population together with the simultaneous growth of urbanization and industrialization has triggered overuse of fossil fuels in the recent years. However, they are non-renewable and release carbon dioxide causing global warming. In this context, biofuels come as excellent substitutes because they are renewable and eco-friendly. They are obtained from biological products and include biodiesel, biomethane, bioethanol, and biohydrogen. They are classified into first, second, and third generation fuels depending on the biological feedstocks being used. Of these, the third-generation fuels, obtained from marine resources like algae, have attracted special research interests because they do not rival the food crop production or depend on land and freshwater for their cultivation. However, the potentialities of macroalgae as a biofuel resource have not been investigated thoroughly. The chapter tries to outline all the aspects of biofuel production from macroalgae pointing out the scopes for future research.

INTRODUCTION

Overexploitation of the fossil fuels and the non-renewable energy resources like coal, petroleum and natural gas in the last few years has not only led to the depletion of resources but has also added carbon dioxide (CO_2) to the atmosphere. Needless to say, CO_2 is a major greenhouse gas (GHG) and causes global warming (Naik et al., 2010). The problem has been projected to rise in the years to come. This necessitates the development of alternative energy sources to meet the growing demands of the burgeoning popula-

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