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Third generation biofuel from Algae

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Abstract

The use of liquid fossil fuel as an energy source has long been considered unsustainable and most importantly the liquid fossil fuel will be diminished by the middle of this century. In addition, the fossil fuel is directly related to environmental degradation and greenhouse emission. Biofuel produced from plants, animals or algae products can offer an alternative to reduce our dependency on fossil fuel and assist to maintain healthy global environment. Micro-algae is becoming popular candidate for biofuel production due to their high lipid contents, ease of cultivation and rapid growth rate. This paper reviews the current state-of-the-art of biofuel from algae as a renewable energy source.

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Keywords: Biofuel, microalgae, biodiesel, bioethanol, renewable energy.

1. Introduction

The growing concern surrounding the continued use of fossil fuels and rapid depletion of fossil fuel reserves, global climate change, rising crude oil price and environmental degradation have forced governments, policymakers, scientists and researchers to find alternative energy sources. The biofuel production from renewable sources is widely considered to be one of the most sustainable alternatives to fossil fuels and a viable means for environmental and economic sustainability. The biomass of currently produced biofuel is human food stock, which is believed to cause the shortage of food and worldwide dissatisfaction especially in developing nations.

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Microalgae are currently being promoted as an ideal third generation biofuel feedstock because of their rapid growth rate, greenhouse gas fixation ability (net zero emission balance) and high production capacity of lipids (fat). They also do not compete with food or feed crops, and can be grown on non-arable land and saline water. Biofuels are generally referred to solid, liquid or gaseous fuels derived from organic matter [1]. The classification of biofuels is shown in Fig. 1 [2].

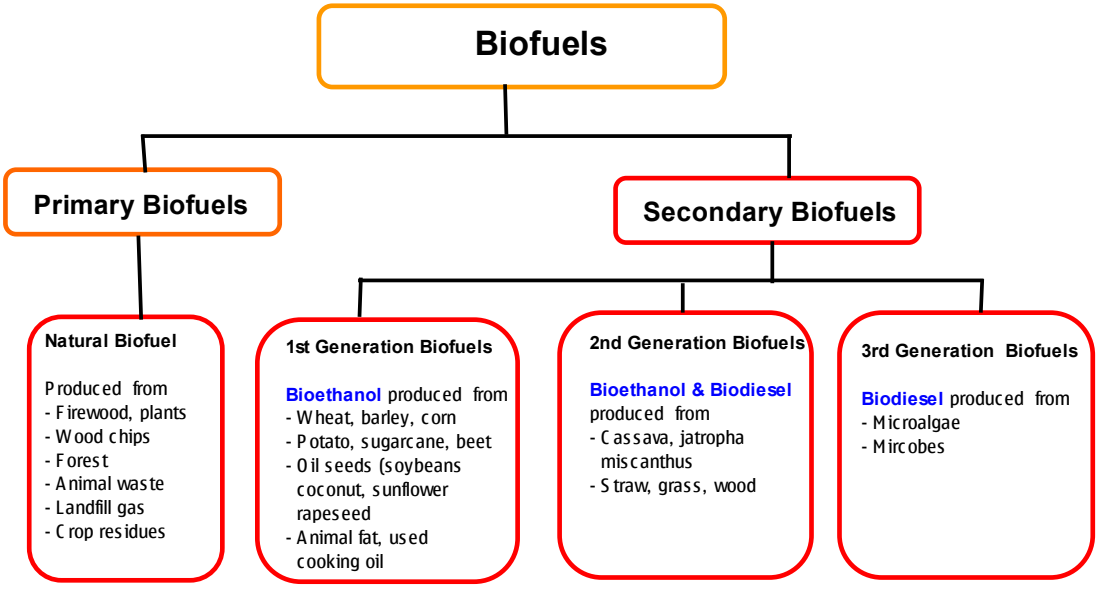

Fig. 1. Biofuel production sources (biomasses) (adapted from [2, 12]).

The first generation biofuels possess notable economic, environmental and political concern as the mass production of biofuel requires more arable agricultural lands resulting in reduced lands for human and animal food production. Moreover, production process of first generation biofuels is also responsible for environmental degradation. Therefore, enthusiasms about first generation biofuels have been demised. As first generation biofuels are not viable, researchers focused on second generation biofuels. Because of the second generation biofuels production process requires expensive and sophisticated technologies, the biofuel production from the second generation is not profitable for commercial production [2, 4]. Therefore, the researchers focused on third generation biofuels. The main component of third generation biofuels is microalgae as shown in Fig. 1. It is currently considered to be a feasible alternative renewable energy resource for biofuel production overcoming the disadvantages of first and second generation biofuels [1- 2, 5, 16]. Microalgae can provide several different types of renewable biofuels. This includes methane [6], biodiesel [9] and bio-hydrogen [29]. There are many advantages for producing biofuel from algae as microalgae can produce 15 to 300 times more biodiesel than traditional crop on area basis [2]. The harvesting cycle of microalgae is very short and growth rate is very high [2, 15]. Moreover, high quality agricultural land is not required for microalgae biomass production [3].

2. Biofuel Production from Microalgae

Microalgae are single-cell microscopic organisms which are naturally found in fresh water and marine environment. There are more than 300,000 species of micro algae, diversity of which is much greater than plants [3]. Microalgae are generally more efficient converters of solar energy comparing to higher plants. In addition, because the cells grow in aqueous suspension, they have more efficient access to water, CO_2, and other nutrients [2, 5]. The current biofuel yields from various biomasses are shown in Table 1. The table clearly shows huge potential of microalgae compared to other biomasses.