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Recent scenario and technologies to utilize non-edible oils for biodiesel production

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ABSTRACT

It is well known that energy consumption is rapidly increasing due to population growth, higher standard of living and increased production. Significant amounts of energy resources are being consumed by the transportation sector leading to the fast depletion of fossil fuels and environmental pollution. Biodiesel is one of the technically and economically feasible options to tackle the aforesaid problems. Biodiesel is produced mainly from edible oils. However, it is believed that the extensive use of edible oils for biodiesel production may lead to food shortages in most of the developing countries. Therefore, the aim of this paper is to review the necessity and potentiality of the non-edible oils and to identify the emerging technologies to produce biodiesel. Special attention has been paid to the impact of biofuels on agricultural commodity prices and the food–fuel debate.

Contents

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1. Introduction

It is well known that a considerable amount of biodiesel is produced from edible oils [1]. However, the extensive use of edible oils might lead to some negative impacts such as starvation and higher food prices in developing countries [2]. For instance, in Malaysia the biodiesel refineries have created shortages in palm oil. Therefore the price of palm oil for cooking has risen by 70% [3]. The rising food prices may be beneficial to the poor farm producers but at the same time they are unlikely to benefit the urban poor [4]. Some researchers have pointed out that developing the technology to convert cellulosic materials into biofuels will significantly reduce food shortage problems [5]. In addition to this, the waste edible oil may be made primary feedstock and the fresh edible and non-edible oils should be made supplement feedstocks. This may reduce the food shortages significantly [6]. However, many of the researchers agree that non-edible oils are the suitable alternative to edible oils for biodiesel production. Hence, the recent focus is to find non-edible oil feedstocks for biodiesel production [7].

Many of the reviewing papers have tried to report the necessity and feasibility of non-edible oils for biodiesel production. A lot of work is being carried out on biodiesel production from Jatropha oil in countries like India, Malaysia and Indonesia [8–12].

However, recent trends and technologies for the production of biodiesel from non-edible oils and the impact of price rise of the food commodities due to the consumption of edible oils for biodiesel have not yet attracted the attention they deserve.

The aim of this paper is to emphasize the effects of food shortages due to the consumption of edible oils and to present the different potentials of non-edible feedstocks for biodiesel production. Special attention has been paid to established processes and considerations for emerging technologies of potential interests.

2. International trends in food demand and supply

There are concerns regarding whether a growing population can be fed in a sustainable manner or not [13]. When dwarfism was introduced in wheat and rice, yields were raised by 2–3% per year during two to three decades [14]. The Malthusian prognosis has been undermined by an exponential increase in world food supply, mainly maize, rice and wheat since 1960 [15]. The development of innovative technologies resulted in both improved genetic traits and advanced crop management. Despite these trends a decline of rice yields from 1985 onwards has been reported for the Indo-Gangetic Plains in India [16]. In spite of these variations in the yield of different crops, there is still a gap between the growth of production and demand of supply. Additionally, there may be other factors but the demand of edible feedstocks for biofuel cannot be ruled out.

3. Food for poor or fuel for rich – a debate

There are many factors which cause the increase in food commodity prices [17]. It is difficult or impossible to separate the reasons responsible for the increase of commodity price other than biofuels. As far as biofuels are concerned, it is argued that one must distinguish between biofuels driven by market forces and biofuels driven by government policy [18]. However, it is accepted globally that biofuels produced from edible feedstocks cannot replace the petroleum fuels without impacting food supplies [19].

4. Effects of elevated food prices on poverty

It has been reported by many researchers and non-governmental organizations that higher food commodity prices adversely affect the poor in general and urban poor in particular. The urban poor in many countries spend a much higher percentage of their income on food [20,21]. The reason for their argument is the production of biofuels. Therefore, for the researchers and scientists the challenge is to produce enough food and biofuel for people in an environmentally sound manner.

5. Biodiesel

Biodiesel is a renewable and clean burning combustible fuel for diesel engines [22]. It is nontoxic, biodegradable, and virtually free from aromatics and sulfur contents [23]. This is because its primary components are domestic renewable resources such as vegetable oil and animal fats consisting of long-chain alkyl (methyl, ethyl, or propyl) esters [24]. Biodiesel is the mono-alkyl esters of fatty acids that result from animal fats or vegetable oils [25]. In other words, biodiesel (fatty acid ester) is the end result of the chemical reaction caused by mixing vegetable oil or animal fat with an alcohol such as methanol. Together these ingredients produce a compound recognized as a fatty acid alkyl ester. A catalyst such as sodium hydroxide is also necessary in order for the biodiesel to be considered a finished product, and is added with the new compounds to produce biodiesel.

Biodiesel offers many advantages as it is [26–30]

- renewable and energy efficient;
- usable in most diesel engines with no or only minor modifications;
- nontoxic, biodegradable and suitable for sensitive environments and
- a fuel with high flash point, positive energy balance and reduced emissions of carbon monoxide (CO), total hydrocarbon (THC) and particulate matter (PM).

Apart from the above advantages, following are the disadvantages of biodiesel: [31,32]

- Biodiesel has 12% lower energy content than diesel.
- Due to the high oxygen content in biodiesel, it produces relatively higher NO_x.
- Biodiesel can cause corrosion in vehicle material.

5.1. Production technologies

The high viscosity, low volatility and polyunsaturated characteristics of vegetable oils make them unsuitable to be used in