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Review

Production and comparison of fuel properties, engine performance, and emission characteristics of biodiesel from various non-edible vegetable oils: A review

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ABSTRACT

Energy demand is increasing dramatically because of the fast industrial development, rising population, expanding urbanization, and economic growth in the world. To fulfill this energy demand, a large amount of fuel is widely used from different fossil resources. Burning of fossil fuels has caused serious detrimental environmental consequences. The application of biodiesel has shown a positive impact in resolving these issues. Edible vegetable oils are one of the potential feedstocks for biodiesel production. However, as the use of edible oils will jeopardize food supplies and biodiversity, non-edible vegetable oils, also known as second-generation feedstocks, are considered potential substitutes of edible food crops for biodiesel production. This paper introduces some species of non-edible vegetables whose oils are potential sources of biodiesel. These species are *Pongamia pinnata* (karanja), *Calophyllum inophyllum* (Polanga), *Maduca indica* (mahua), *Hevea brasiliensis* (rubber seed), Cotton seed, *Simmondsia chinesnsis* (Jojoba), *Nicotianna tabacum* (tobacco), *Azadirachta indica* (Neem), *Linum usitatissimum* (Linseed) and *Jatropha curcas* (Jatropha). Various aspects of non-edible feedstocks, such as biology, distribution, and chemistry, the biodiesel's physicochemical properties, and its effect on engine performance and emission, are reviewed based on published articles. From the review, fuel properties are found to considerably vary depending on feedstocks. Analysis of the performance results revealed that most of the biodiesel generally give higher brake thermal efficiency and lower brake-specific fuel consumption. Emission results showed that in most cases, NOx emission is increased, and HC, CO, and PM emissions are decreases. It was reported that a diesel engine could be successfully run and could give excellent performance and the study revealed the most effective regulated emissions on the application of karanja, mahua, rubber seed, and tobacco biodiesel and their blends as fuel in a CI engine.

Contents

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1. Introduction

Since the industrial revolution, different forms of energy have become essential for human beings to maintain a standard of living and to conserve economic growth. In the past few decades, fossil fuels, mainly petroleum-based liquid fuels, natural gas and coal, have played an important role in fulfilling this energy demand. However, because of their non-renewable nature, these fossil fuels are projected to be exhausted in the near future. This situation has worsened with the rapid increase in energy demand with significant worldwide population growth. Therefore, the demand for clean, reliable, and yet economically feasible renewable energy sources has led researchers to search for new sources. In this context, biodiesel derived from vegetable oil has drawn attention as a potential alternative for diesel fuel for diesel engines.

1.1. Current energy scenario

Gobal energy demand is increasing dramatically because of rising population. In 1980, fuel consumption was 6630 million tons of oil equivalents (Mtoe). It almost doubled in 2012 at 12,239 Mtoe, as shown in Table 1 [1]. According to the International Energy Agency estimation, global energy demand is expected to increase by 53% by 2030. Currently, a major part of energy demand (88.6%) is fulfilled by fossil fuels, in which crude oil accounts for 33.7%, coal for 30.5%, and natural gas for 24.4% [2]. Conversely, nuclear energy and hydroelectric energy contribute only small proportions at 4.6% and 6.8%, respectively. Over the past 25 years, total energy supply has increased steadily. However, with the current consumption rates, the reserves of crude oil and natural gas will diminish after approximately 41.8 and 60.3 years, respectively. The total primary fuel consumption was estimated to reach approximately 12,239 Mtoe in 2012; the estimate is 70% higher than that in 1987, as shown in Fig. 1 [1]. Globally, we consume the equivalent of more than 11 billion tons of oil in fossil fuel every year. Crude oil reserves are vanishing at a rate of 4 billion tons a year. If this rate continues, oil deposits will be exhausted by 2052 [3]. However, if increased gas production can fills up the energy gap left by oil, then those reserves will give an additional backup of eight years until 2060. The world has enough coal reserve to a last century, but production is necessary to fill the gap caused by depleting oil and gas reserves. Coal deposits will give us enough energy to last as long as 2088. Moreover, the rate of energy consumption in the world is not steady, as it increases dramatically with the increase in global population and living

Table 1
World primary energy consumption and percentage of share [1].

Source	1980		2012	
	Mtoe	Share (%)	Mtoe	Share (%)
Petroleum	2979.8	44.9	4130.5	33.7
Coal	1807.9	27.3	3730.1	30.5
Natural gas	1296.8	19.6	2987.1	24.4
Nuclear	161	2.4	560.4	4.6
Hydropower	384.3	5.8	831.1	6.8
Total	6629.8	100	12239.2	100