Chapter 10

Non-Edible Vegetable Oils as Renewable Resources for Biodiesel Production: South-East Asia Perspective

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Additional information is available at the end of the chapter

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Abstract

Biodiesel derived from plant species has been a major renewable source of energy and has received global interest mainly due to climate change issue. It has increasingly received worldwide attention as a promising alternative fuel. Growing interest in biodiesel production from edible oil brings scarcity in food supply. To overcome this problem, utilization of non-edible oils could be explored. Non-edible oil as biodiesel feedstock impressed in many factors such as energy sustainability and independence in certain areas, especially in rural community, creating job opportunities, elevating environmental merits, and avoiding monoculture of fuel resources. The present chapter reviews several such potentials, including fatty acid methyl ester (FAME) or biodiesel production process of non-edible oil resources as biodiesel feedstock in South-East Asian geographical region. The South-East Asian countries fall in the tropical region of the world and have many species as non-edible oil, viz., jatropha, karanja, polanga, neem, rubber, and mahua. The oils derived from these species have shown considerable potential as biodiesel feedstock.

Keywords: biodiesel, oil properties, renewable energy, potential crop, FAME

1. Introduction

Biodiesel has energy sustainability benefit for most of the countries in Asia, aiming to reduce nations' dependence on fossil fuels, who still import the oil and other petroleum product [1, 2]. It is also considered as the final strategy for clean development mechanism (CDM). Utilization of edible oil as feedstock for biodiesel production has increased its price and created demand in the world market [3]. More than 60% of the world's population resides in Asia leading to a higher demand for food and energy. Utilizing non-edible oils as a biodiesel feedstock assists the sustainability of biodiesel production and minimizes the impact directly on food supply [1].

2. Non-edible oil merits as biodiesel feedstock

Deforestation and destruction of ecosystem due to urbanization and plantation expansion is a big issue in utilizing edible oil as biodiesel feedstock. Furthermore, the boundary line between food and fuel is blurred since both the fields are competing for the same resources. Debating over food versus fuel is still a dilemma. There are large surplus of food crops in developed countries. However, millions of people in developing countries still face the scarcity of food. Conversion of food crops such as palm oil, coconut oil, corn, soybean, and sugarcane to biodiesel could lead to serious food shortage. Countries in South-East Asia fall in the tropical belt and have many species of crops both edible as well as non-edible ones. Developing biodiesel production based on non-edible oil is one of the scenarios for fuel security without interfering with the food supply. This is especially true for palm oil which makes up about one-third of vegetable oil as biodiesel feedstock and has become the hottest environmental topic in South-East Asia.

High price of high quality refined edible oil makes them not feasible as tent to uneconomic for developing countries like India due to high production cost of methyl or ethyl ester from the edible oil. The cost is about four times higher compared to the cost of diesel [4]. Valuable nutrient elements in edible oil such as essential amino acids, β-carotene, α-carotene, vitamin-E, lycopene, tocotrienols, and carotenoids will be neglected, if this oil is converted to fuel.

Non-edible crops can grow in waste and unproductive land which may be helpful for reclaiming the land [1, 5, 6]. Furthermore, non-edible oils may contain toxic substances such as triterpenoids and strong odor in neem oil, and furanoflavones, furanoflavonols, chromeno-flavones, flavones, and furanodiketones in karanja oil [7]. Rubber seed oil contains cyanogenic glucoside that yields poisonous prussic acid (HCN) due to enzymatic reaction [8]. Jatropha oil contains toxic phorbol esters (0.03–3.4%) [9] or curcain [10], depending on the variety. Hence, it is better to exploit these non-edible oils as feedstocks for biodiesel production.

2.1. Non-edible oil crops in South-East Asia

Jatropha (*Jatropha curcas*) was not the only prominent non-edible oil crop. Other crops such as karanja (*Pongamia pinnata*), polanga (*Calophyllum inophyllum*), and neem (*Azadirachta indica*) were also found to be promising as alternative biodiesel feedstocks [11]. Rubber (*Hevea brasiliensis*) and mahua (*Madhuca indica*) have also shown potential and needs to be explored as biodiesel feedstock (**Figure 1**). The oil from the seed of these plants (**Figure 2**) has been considered as a waste material as it is non-edible; hence, they have the significant potential for biodiesel production.

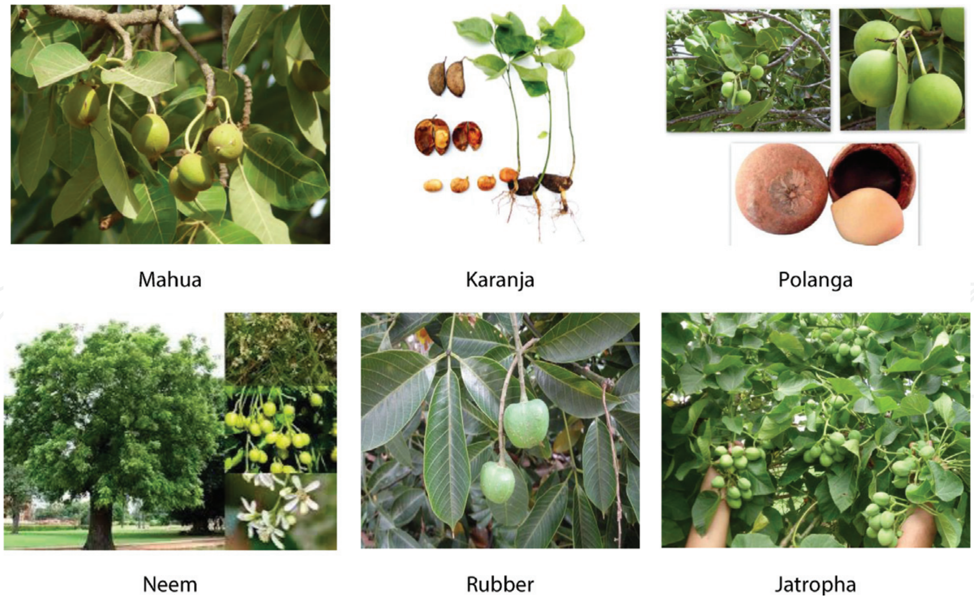

Figure 1. Six different species of non-edible vegetable oils as renewable sources for biodiesel.

Figure 2. Seeds of six different species of non-edible vegetable oils as renewable sources for biodiesel.

2.1.1. *Jatropha* (Jatropha curcas *L.)*

Jatropha curcas L., a member of the family Euphorbiaceae, is a large drought-resistant multipurpose shrub with several attributes and considerable potential, and has evoked interest all over the tropics as a potential biofuel crop [12]. The lifespan of this perennial bush is more than 50 years, and it can grow on marginal soils with low nutrient content [12, 13]. Seed production is from 0.2 kg to more than 2 kg per plant [5]. The average weight per 1000 seeds is about 500–800 g, which is equivalent to 1333 seeds per kg. The seed coats constitute about 35–40% of the total seeds. The oil content in seeds ranges from 35 to 40% and the kernels 55–60% (www.jartropha.org) [14]. Many investigations have been done on the composition and content of the jatropha seeds [15]. Optimal seed yield in good condition area is around 5 t dry seed $ha^{-1}y^{-1}$ [16]. Seed oil contain 22.50% saturated fatty acid (16.00% palmitic acid, 6.50% stearic acid) and 78.70% unsaturated fatty acid (43.50% oleic acid, 34.40% linoleic acid, 0.80% linolenic acid) [6].

2.1.2. *Karanja (*Pongamia pinnata *(L.))*

Pongamia pinnata (L.) Pierre (Family Fabaceae – Papilionoideae) is native to India and commonly known as karanja [17]. It has been introduced to humid tropical lowlands in the Philippines, Malaysia, Australia, the Seychelles, the United States of America, and Indonesia [18]. In fertile soil, *P. pinnata* can produce 10–50 kg of seeds/tree and reach yearly production of around 200 t (metric ton) [19]. Seeds of *P. pinnata* are heavy, contain greater food reserves and around 800–1200 seeds are found to weigh 1 kg. As a legume, it is also able to fix its own nitrogen from the soil thus minimizing the need for adding fertilizer. Further, it has positive bio-ameliorative effect on the nitrogen, phosphorous, potassium, and organic carbon content of soil. The oil seed consists 19.15% saturated fatty acid (11.65% palmitic acid, 7.50% stearic acid) and 70.70% unsaturated fatty acid (51.59% oleic acid, 16.46% linoleic acid, 2.65% linolenic acid) [20].

2.1.3. *Polanga (*Calophyllum inophyllum *L.)*

Calophyllum inophyllum L., a member of Clusiaceae family, is native to Australia and has many attributes to be used as a biodiesel feedstock [21]. It fruits profusely (3000–10,000 seeds $tree^{-1}$ $season^{-1}$) and requires little maintenance [22]. Productivity of polanga is 3744 kg/ha (dry weight) within density 400 trees/ha [11]. Seed yields 65% oil that contains 24.96% saturated fatty acid (12.01% palmitic acid, 12.95% stearic acid) and 72.65% unsaturated fatty acid (34.09% oleic acid, 38.26% linoleic acids, 0.30% linolenic acid) [6].

2.1.4. *Neem (*Azadirachta indica*)*

Azadirachta indica is a member of the family Meliaceae and is native to Indian subcontinent. It can be grown by seeds in rainy season and reach the maximum productivity after 15 years. The adult plants reach at the height of 25–30 m and bears fruit at the age of 3–5 years. Neem tree produce around 40–50 kg fruits per plant per year equivalent to 25–30 kg seeds in its full growth [23]. Average seed yield of neem is 2.67 ton/ha at density 400 plants/ha [11]. The neem oil yield that can be obtained from the seed kernels varies from 25 to 45% [11].

2.1.5. *Rubber (*Hevea brasiliensis*)*

The rubber tree is a perennial plantation crop, indigenous to South America and cultivated as an industrial crop since its introduction to South-East Asia around 1876. Rubber tree can grow in hot and moist regions. Its productivity starts from eighth year onwards. The yield of the

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seeds is about 300–500 kg/ha/year [24]. Rubber seed kernels (50–60% of seed) contain 40–50% of pale yellow oil [25–27]. Rubber seed oil does not contain any unusual fatty acids, but is rich in polyunsaturated fatty acids C18:2 and C18:3 that make up 52% of its total fatty acid composition [28]. Rubber seed oil contains 18.90% saturated fatty acid (10.20% palmitic acid, 8.70% stearic acid) and 80.50% unsaturated fatty acid (24.60% oleic acid, 39.605 linoleic acid, 16.30% linolenic acid) [29].

*2.1.6. Mahua (*Madhuca indica*)*

Madhuca indica is a member of the family Sapotaceae and is commonly known as Butter Tree. Mahua oil is obtained from the seed kernel. The tree is medium to large and found in Asia. Average productivity of mahua seed is about 1.6 kg/tree [30]. The seeds contain 30–40% fatty oil, which is non-edible and used in the manufacture of various products such as soap and glycerin. It contains 31.80% saturated fatty acid (17.80% palmitic acid, 14.00% stearic acid) and 64.20% unsaturated fatty acid (46.30% oleic acid, 17.90% linoleic acid) [11].

3. Characteristic of non-edible oils

Characteristics of vegetable fats and oils depend on the length and degree of un-saturation of the fatty alkyl chains. Thus, the fatty acid plays an important role in determining biodiesel characteristics. Amount of each fatty acid, chain length, and number of double bond present in the hydrocarbon chain influences the biodiesel properties [31]. The stability of biodiesel also depends on the feedstock properties used for biodiesel production. The most abundant fatty acids in the oil samples were oleic, linoleic, linolenic, palmitic, and stearic fatty acid. Oleic acid comprises of a major portion of the total fatty acid irrespective of non-edible oil summarized in **Table 1**. All oils have high unsaturated fatty acids (up to 80%) which mean they have good low

Properties	Jatropha	Karanja	Polanga	Rubber	Mahua	Neem	Diesel
Saturated fatty acid							
Palmitic ($C_{16:0}$)	16.0	11.7	12.0	10.2	17.8	14.9	—
Stearic ($C_{18:0}$)	6.5	7.5	12.9	8.7	14.0	14.4	—
Total	22.5	19.2	24.9	18.9	31.8	29.3	—
Unsaturated fatty acid							
Oleic ($C_{18:1}$)	43.5	51.6	34.1	24.6	46.3	61.9	—
Linoleic ($C_{18:2}$)	34.4	16.5	38.3	39.6	17.9	7.5	—
Linolenic ($C_{18:3}$)	0.80	2.7	0.30	16.3	—	—	—
Total	78.7	70.8	72.4	80.5	64.2	69.4	—
Cetane number	52.3	55.8	57.3	—	40	57.8	46
Oilseed content, %w	55	33	65	40–50	50	44.5	—
FFA %w	14	2.5	22	17	20	—	—
Specific gravity	0.92	0.91	0.90	0.91	—	—	0.84

Properties	Jatropha	Karanja	Polanga	Rubber	Mahua	Neem	Diesel
Viscosity 40°C (mm^2/s)	18.2	27.8	72.0	76.4	24.6	—	7.50
Flash point	174	205	221	198	232	—	50
Calorific value (Mj/kg)	38.2	34.0	39.3	37.5	36	—	42.25
Iodine value	93.0	80.9	93.8	135.3	74.2	69.3	38.3

Sources: Azam et al. [11], Ghadge and Raheman [35], Karmee and Chadha [42], Puhan et al. [30], Ramadhas et al. [5, 29], Tiwari et al. [16], Sahoo and Das [20], Islam et al. [53].

Table 1. Characteristic and composition of several non-edible oils compared to diesel.

temperature properties and are suitable as biodiesel feedstocks (**Figure 3**). Higher concentrations of saturated fatty acids can increase cloud point (CP) and cold filter plugging points (CFPP), which makes them undesirable as liquid fuel [31, 32]. On the other hand, unsaturated fatty acids helps to maintain oil in liquid form, but if the concentration of polyunsaturated fatty acids exceeds certain limit they can form polymers under heat which can block the fuel system of a vehicle [11]. The oils with larger proportion of saturated fatty acids will be more stable than those having larger portion of unsaturated fatty acids. But again, higher proportion of saturated fatty acids lowers the temperature for becoming solid even in the room temperature.

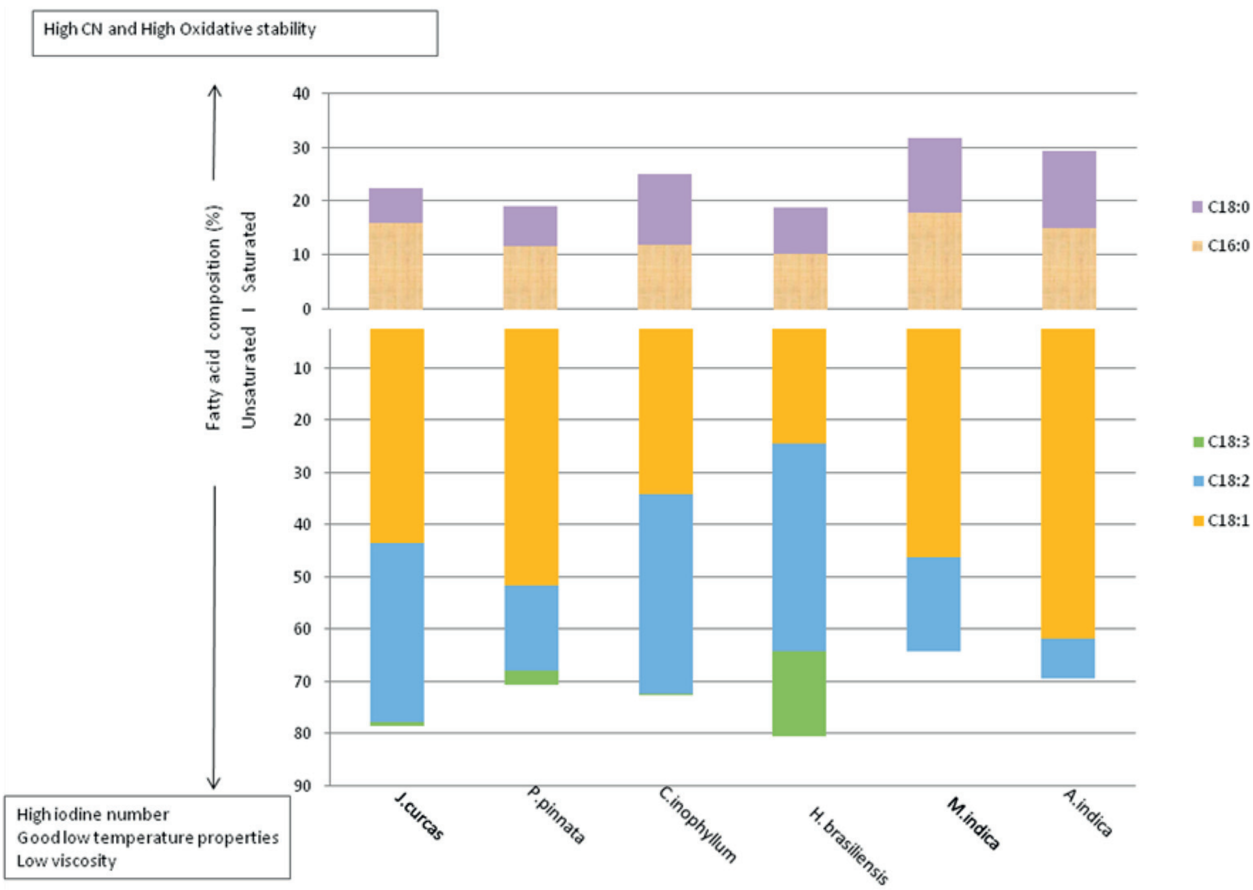

Figure 3. Distribution of fatty acid and its influence on the characteristics of biodiesel in different non-edible oils.

The presence of double bond in the fatty acid brings diesel on poor stability. This decomposition occurs very fast at an exponential rate.

The amount and type of free fatty acid (FFA) in the biodiesel determines the viscosity, one of the most important characteristics of biodiesel. Due to the presence of higher amount of long chain FFA, polanga (72.0 mm^2/s) and rubber (76.4 mm^2/s) seed oils may have a slightly higher viscosity compared to others. Karanja and mahua oil has similar viscosity, due to the presence of same FFA. Iodine value represents the degree of unsaturation and relatively high iodine value is reported in range 69.3 in neem to 135 in rubber seed oil (**Table 1** and **Figure 1**). These properties are relatively applicable in cold climates. From calorific value, non-edible oils have potential to be biodiesel feedstocks.

Cetane number (CN) is widely used as diesel fuel quality parameter related to the ignition delay time and combustion quality [14, 32]. Higher cetane numbers in all vegetable oils listed in **Table 1**, will give better ignition properties. Cetane number increases with the increase of saturated fatty acid, and increases linearly with the chain length, decrease with number of double bonds and carbonyl groups move toward the center of the chain. High level of saturated fatty acid (C14:0, C16:0, C18:0) raise cloud point, cetane number, NOx, and improve stability, while more polyunsaturated (C18:2, C18:3) reduce cloud point, cetane number, stability, and raise NOx.

4. Barrier of transesterification process for non-edible oils

Generally, non-edible oil has high free fatty acid content of 2.53–22% in weight basis. Alkaline transesterification is not feasible for oil containing high free fatty acid for producing biodiesel [33, 34]. It generates soap, consumes more catalyst and reduces the effectiveness of catalyst. Subsequently, soap causes the solution to be more viscous, and leads to the formation of gel and foam that inhibits purification of biodiesel from glycerol [35]. To overcome this dilemma, biodiesel production from non-edible oils that has high free fatty acid was conducted by several methods; two/three stages reaction, acid-catalyzed esterification and alkaline-catalyzed transesterification; enzymatic process; and supercritical methanol [36, 37]. In enzymatic process, water content in the raw material does not interfere to the reaction conducted in low temperature. Lipase reaction occurs at the interface between the aqueous and oil phase [38] which generates alkyl ester with high purity and easy separation [39]. Due to deactivation of catalyst and time cut in a few minutes, supercritical transesterification in high temperature and pressure can tolerate presence of high percentage of water in the feedstock [40–42].

5. Biodiesel production from non-edible oil

Several studies have shown that there exists an immense potential for the production of plant-based oil to produce biodiesel. Azam et al. [11] studied the prospects of fatty acid methyl esters (FAME) of some 26 non-traditional plant seed oils as potential biodiesel feedstocks. Among them, *J. curcas*, *A. indica*, *C. inophyllum*, and *P. pinnata* were found to be the most suitable for use as biodiesel and they met the major specification of biodiesel for use in diesel engine.

5.1. Jatropha

Most of the researchers [20, 36, 43, 44] used two stage (acid catalyzed and alkaline catalyzed) esterification for biodiesel production from *J. curcas* oil due to its high free fatty acid content. Ortho-phosphoric acid is used as catalyst and degumming agent in acid esterification stage [20]. Pre-esterification is the first stage that uses sulfuric acid prepared by calcination of metatitanic acid as a catalyst. The conversion of FFAs was higher than 97% under the reaction conditions of 90°C, 2 h, 4% solid acid, and molar ratio of 20:1 of methanol to FFA. Then alkaline catalysis was carried out for 20 min, 64°C using 1.3% KOH as catalyst and molar ratio of 6:1 of methanol to oil. Berchmans and Hirata [43] achieved 90% yield in 2 h alkaline transesterification and Sahoo and Das [20] achieved 93% yield. Lu et al. [44] produced biodiesel and achieved yield up to 98% from jatropha oil with FFA over 20%. Complete conversion and the highest yield was conducted in supercritical methanol [36] within 4 min with temperature at 320°C, pressure 8.4 MPa, molar ratio absolute methanol to oil was 43:1 as optimum ratio [45]. Supercritical was success at temperature above 327°C and pressure above 8 MPa since ester yield increase rapidly at that state. From technical and environmental point of view, supercritical is appropriate for biodiesel production due to less glycerol waste but from economic analysis point of view; this method is not appropriate due to its high operating skill and cost. Two stages process can be a good choice, since it can reduce FFA to proper amount below to 1%.

5.2. Karanja

Two-stage process was conducted in producing biodiesel (up to 20% FFA) from *P. pinnata* seed oil [19]. Acid-catalyzed esterification was adopted by using 0.5% (w/w) H_2SO_4, molar ratio of alcohol to oil of 6:1 at 65°C. Next step was alkali-catalyzed transesterification by 1% (w/w) KOH, molar ratio of methanol:oil of 6:1, which was the optimum condition [46]. The yield of biodiesel (96.6–97%) was achieved at 65°C.

5.3. Polanga

Crude polanga oil generally has 22% free fatty acid. Hence, it must be carried out in three-stage process for producing appropriate biodiesel [6, 20, 47]. Three-stage transesterification process was zero catalyzed transesterification, acid catalyzed transesterification, and alkaline catalyzed transesterification. The oil was purified from organic matter and other impurities by mixing 0.5%v toluene and 35%v methanol as reagent. The reaction was carried out at 65°C for 2 h. Acid catalyzed esterification was conducted by 0.65% v H_2SO_4, molar ratio of alcohol to oil of 6:1 for 4 h. This process reduced FFA less than 2%. Sahoo and Das [20] added 0.5%v ortho-phosphoric acid as a reagent that reduced FFA from 14.5 to 1.62%. Alkaline catalyzed transesterification process was conducted by using 1.25% w KOH, molar ratio of methanol to oil of 8:1, 60°C for 2 h. Biodiesel from polanga still gets unsatisfactory yield below 90%. Further research needs to be done to get better yield in order for polanga to be more acceptable in the biodiesel production.

5.4. Neem

Neem seed contains 20–30% and kernel contains 30–52% oil [23]. The oil of neem seed has several uses from making soap, pesticides, and pharmaceuticals to biodiesel. The seed oil contains 29.30% saturated fatty acid (14.90% palmitic acid, 14.40% stearic acid) and 69.40% unsaturated fatty acid (61.90% oleic acid, 7.50% linoleic acid) [11]. Biodiesel production from neem seed oil is quite the same with other non-edible oil resources in order to get appropriate product.

5.5. Rubber

Several researchers produced biodiesel from rubber seed oil [25, 29, 48]. Ikwuagwu et al. [48] produced biodiesel from fresh rubber seed oil, where the FFA in crude oil was 2% and in refined oil 0.5%. The reaction carried out under condition of molar ratio of methanol to oil was 6:1 and 1% NaOH as catalyst, ester yield from crude seed oil was just 76.64% compared to refined oil (84.46%). Ramadhas et al. [29] produced biodiesel from rubber seed oil with high free fatty acid by two stages reaction. Acid esterification reduced FFA of oil from 17% to less than 2% when reaction with 0.5% v H_2SO_4, methanol to oil molar ratio of 6:1, temperature at 50°C for 20–30 min. Final stage was alkaline transesterification, where the oil mixture with methanol to oil molar ratio of 9:1 and 0.5%w of NaOH at temperature 40–50°C during 30 min for achieving conversion efficiency almost 100%. Result from Ramadhas et al. [29] showed rubber seed oil is appropriate as biodiesel feedstock. The viscosity of biodiesel obtained is close to diesel, although yield that Ikwuagwu et al. [48] achieved was considered uneconomical. However, further research is needed for fostering the biodiesel quality as well as more acceptability.

5.6. Mahua

Ghadge and Raherman [35, 49] studied the process optimization for biodiesel production from *M. indica* oil using response surface methodology. FFA content can be reduced from 27% to less than 1% by 0.32 v/v methanol using 1.24% w/v H_2SO_4 as catalyst under reaction condition at 60°C for 1.26 h. Next step was conducted by adding 0.7% w/v KOH, 0.25 v/v methanol to oil molar ratio of methanol 6:1. The biodiesel yield was achieved 98%.

6. Characteristic of biodiesel from non-edible oils

Table 2 represents the fuel properties of methyl esters (biodiesel) from various plant-based oils. Specific gravity of biodiesel methyl esters of six non-edible oils meet the standard biodiesel ranging from 0.86 to 0.89.

Properties	JME	KME	PME	MME	NME	RME	Diesel	Biodiesel standard	
								EN 14214	ASTM 6751–09
Specific gravity	0.86–0.88	0.88–0.89	—	—	—	0.87	0.84	0.86–0.90	0.87–0.90
Calorific value (MJ/kg)	42.7	42.1	41.4	37.0	40.1	36.5	42.5	—	—
Viscosity (mm^2/s) at 40°C	4.2	4.4	4.0	4.0	8.8	5.8	3.8	3.5–5.0	1.9–6.0
Flash point (°C)	148	163	140	208	—	130	45	≥120	≥130
Cloud point (°C)	10.2	14.6	13.2	—	—	4.0	−1.0	—	—
Pour point (°C)	4.2	5.1	4.3	6.0	—	−8.0	−16.0	—	—
Cetane number	60.7–63.3	59.7–60.9	52.5	—	—	—	—	—	47 min

Source: Shaoo and Das [20]; Ghadge and Raherman [49]; Ramadhas et al. [29].
Note: JME = Jatropha Methyl Ester, KME = Karanja Methyl Ester, PME = Polanga Methyl Ester, MME = Mahua Methyl Ester, RME = Rubber Methyl Ester, NME = Neem Methyl Ester.

Table 2. Biodiesel properties from various non-edible oil feedstock.

Viscosities of all non-edible oils were ranging from 3.8 to 8.8, which comply with the standard biodiesel of EN 14214 and ASTM 6791–09, except neem methyl ester (**Table 2**). The neem oil was the most viscous one among the six oils. Consequently, the viscosity of neem methyl ester was the highest in their respective series. Biodiesel derived from jatropha, karanja, polanga, rubber, mahua, and neem were found to comply with the industrial standards.

7. Status of biodiesel production in South-East Asia

Recently, biodiesel production from non-edible oil has risen. In South-East Asia, countries such as Indonesia, Malaysia, Philippines, and Thailand have taken initiatives to develop biodiesel from non-edible oil generally using *J. curcas*. Indonesia has taken several steps in biodiesel roadmap including target to use 10% of diesel fuel consumption of 2.41 million kL within 2005–2010, spread out over Indonesia including Sumatera (Riau, Medan, South Sumatera, Jambi, and Dumai), Banten, West Kalimantan, Balikpapan, Papua, and Merauke in 2007–2011. Biodiesel utilization will increase in 15% of diesel fuel consumption of 4.52 million kL by 2011–2015 and finally 20% of diesel fuel consumption of 10.22 million kL within 2025 [50]. Indonesia developed *J. curcas* and *C. inophyllum* as biodiesel feedstock. The country plans to breed 10 million of *C. inophyllum* seeds on 10,000 ha in Madura [51]. The Ministry of Forestry, Republic of Indonesia reported that, the engine runs well without problem on a road test with 370 km mileage by using biodiesel obtained from *C. inophyllum*.

Malaysia started with breeding high quality *J. curcas* seeds, sets-up the country policy, proper process and invests in the land for jatropha cultivation for biofuel production since 2005. Malaysia has also invested in processing plants and *J. curcas* [52, 53] plantations. On the other hand, Malaysia is also arranging partnership with private sectors in further expansion of jatropha plantations. Philippines has also developed *J. curcas* plantations through Philippinea National Oil Company (PNOC) and expect at least 700,000 ha jatropha plantations in the Mindanao area with yield of 300 gallons of biodiesel per acre [54]. The government arranges the mandate of utilizing biodiesel B2 in 2011. Jatropha is prominent biodiesel feedstock in Thailand [55] as well. Thailand started using biodiesel B2 in Cheiang Mai area and plans to increase the use of B5, B10 in 2011 and 2012, respectively. Thailand also plans to collaborate with Laos, Myanmar, and Cambodia in biofuel development.

8. Conclusion

Production of biodiesel from edible oil such as palm, coconut, soybean, corn, rape seed oils, or other food crops like sugarcane will lead to severe shortage in food and its security. High price of edible oil makes them not feasible for the production biodiesel. In this situation, use of oils from non-edible sources may increase fuel security without interfering with the food security. South-East Asian countries fall in the tropical region and have many species of crops of non-edible oil. The non-edible crops can grow in waste as well as in marginal lands which may be helpful for reclaiming the unproductive areas. It is better to exploit these non-edible oils as feedstocks for biodiesel production. Major non-edible plants in this region are jatropha, karanja, polanga, neem, rubber, and mahua have shown significant potential as biodiesel feedstock. Biodiesel properties and fatty acid composition has in-direct correlation because transesterification cannot change the fatty acid composition. Fatty acid compositions give paradoxal properties among cetane number, low temperature properties, and stability of the products. Optimal characteristics could not be achieved within this current time. At present the end usage production is low and utilization of these oils are limited. Exploitation and utilization of these non-edible oils as biodiesel feedstock can save foreign currency, fossil fuel dependency, and equally improve the rural economy as well as future job opportunities.

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