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Assessment of Potential Non Edible Oil as Biodiesel Feedstocks in Ethiopia

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ABSTRACT

Biodiesel is an alternative to petroleum-based fuels derived from a variety of feedstocks, including vegetable oils, animal fats, and waste cooking oil. At present, biodiesel is mainly produced from conventionally grown edible oils such as soybean, rapeseed, sunflower, and palm. The cost of biodiesel is the main obstacle to commercialization of the product. Biodiesel produced from edible oils is currently not economically feasible. On the other hand, extensive use of edible oils for biodiesel production may lead to food crisis. These problems can be solved by using low cost feedstocks such as non-edible oils and waste cooking oils for biodiesel production. This paper reviews numerous options of non-edible oils as the substantial feedstocks.

Keywords: Non-edible oil; Biodiesel; Fuel; Biodegradable; Feedstock

INTRODUCTION

The investigation of indigenous resources as a separate force is a matter of common sense and common sense solution for the elimination of crude oil resources, environmental concerns and high uncertainty in ensuring its constant availability at a sustainable price. Because, Ethiopia is endowed with a wide variety of ecosystems, this provides the country with unique potential sources of energy such as wind, solar, hydropower, and biomass energy. Among the various sources of energy biodiesel fuel has received special attention in this particular study, as it is easy to produce from easily available and renewable sources, safe to handle and use, eco-friendly and completely blended with mineral fuel in any component and used directly on existing diesel engines. In addition, in the case of Ethiopia, energy security and sustainable economic development are a critical issue as well as the country's trade deficit due to the importation of petroleum. Today, all Ethiopian petroleum products are imported into the Djibouti port or from Sudan. Another important issue is that about 65% of remittances must be paid for the purchase of petroleum products. Therefore, the country is among the countries most dependent on the purchase of petroleum oil as a source of energy especially in various industries and the transport sector [1].

At present, a steady decline in conventional fuel fuels is growing the use and release of GHG has led to the advancement of other, renewable, sustainable products, less efficient and less expensive energy sources. Among the many renewable energy sources source, biodiesel is strategically important for sustainable oil sources in the foreseeable future as well which could directly change diesel fuel. Biodiesel is a non-petroleum fuel that contains methyl or ethyl esters of fatty acids obtained by transesterification of triglycerides from plant sources. It has a number of environmental benefits in addition to petroleum diesel such as gas pollution and toxicity, biodegradability decay, found in renewable and domestic cells, negligible sulfur content, high brightness and high burning due to its high oxygen content. These are all great features that have been able to draw a lot of attention to it. With a good viscosity, perfectly blended with regular diesel fuel and calorific value all these biodiesel features make it suitable for use with diesel engines without modification in any design [2]. As the use of biofuels instead of natural residues will slow down, the continuation of global warming by reducing sulfur, carbon oxides and hydrocarbon emissions. Thus, the gradual replacement of diesel fuel with biofuel may increase the termination of petroleum resources and prevent further climate change caused by automotive and industrial pollution. Previously, biodiesel was produced in a variety of plants including: Jatropha, Croton, Sunflower, soy, Rapeseed, Castor, Palm, peanuts are the most common source of biodiesel. However, it is good that biodiesel should be produced from plants that can be eaten as Jatropha, croton, castor, and safflower. This ensures food safety and is cheap or reduced production costs of biodiesel as there is no competition for fossil fuels [3].

LITERATURE REVIEW

Biodiesel production is a very modern and technologically advanced facility for researchers due to the importance of winning every day due to rising petroleum prices as well environmental benefits [4]. Biodiesel can be found in a variety of sources including vegetable oils, animal fats, and cooking fats. Vegetable oils, also known as triglycerides, are chemically triglycerides molecules. Three groups of ester fatty acids are attached to one glycerol molecule. Vegetable oils appear renewable oil seeds can be used when mixed with diesel fuel [5]. Advantages of vegetable oils such as diesel fuel, its efficiency, availability, regeneration, high heat content (approximately 88% of it incomplete [6]. Vegetable oil all looked very good, with viscosity ranging from 10-20 times greater than no.2 Diesel fuel [7].

Mixing vegetable oils with diesel, however, greatly reduces viscosity and the engine fuel management system can handle diesel-vegetable oil mixtures without any problems [8]. Converting vegetable oil into Fatty Acid Methyl Esters (FAME) is an effective way to overcome all the problems associated with vegetable oils. Most biodiesel is currently made from soybeans, rapeseed, sunflower, and palm oil [9].

Newly considered vegetable oils include mustard seeds, nuts, sunflowers, and cotton seeds. Soybean oil is widely used in the United States and rapeseed oil is used in many European countries for biodiesel production, and coconut oil and palm oil are used in Malaysia and Indonesia for biodiesel production.

Food *vs.* fuel

The biggest obstacle to the sale of biodiesel costs is about 70%-90% of biodiesel costs come from resource costs [10]. Therefore, biodiesel produced by edible vegetable oils is currently not economically feasible. Inedible oil plants are more readily available in developing countries and are more economical than edible vegetable oils. Biodiesel production from various oil seed plants has been extensively investigated over the past few years.

Excessive consumption of edible fats can cause other important problems such as starvation in developing countries. Using edible fats to produce biodiesel raises serious concerns about healthy eating and behavior. About 13% of global vegetable oil supplies are used for biodiesel production in 2012. World annual petroleum consumption and production of vegetable oil is about 4.018 and 0.107 billion tons, respectively [11]. Biodiesel production accounted for 25.6% of global seed demand, 16.1% of global soybean demand, and 5.9% of global palm oil demand in 2012.

On the other hand, excessive consumption of edible vegetable oils may result in some significant side effects problems such as hunger in developing countries. There are concerns that biodiesel feedstock may compete with long-term food supply [12]. Biodiesel, a non-vegetarian vegetable, has great potential as an alternative to diesel fuel. Consumption of non-edible vegetable oils compared to edible vegetable oils is very important due to the high demand for edible fats as a food, and is too expensive to be used as fuel at present [13]. Non-edible oil plants can be grown in abandoned areas that are not suitable for food crops and the cost of cultivation is very low because these crops can still produce high yields without intensive care [14]. Non-edible oil plants are well adapted to dry, dry conditions and require low fertility and the need for moisture to grow [15].

Non-edible vegetable oils as raw material: In order to overcome the problems listed above, research has been done to produce it biodiesel by using different resources such as edible vegetable oils. Fat comes from non-edible resources are not suitable for human consumption due to the presence of toxic components [15]. Vegetable fats can be edible and therefore are expected to help biodiesel become more competitive compared to the consumption of dietary vegetable oils. The advantages of non-edible vegetable oils such as diesel fuel are their natural sensitivity to liquid, readiness, rejuvenation, high efficiency of combustion, low sulfur, and aromatic content and high biodegradability [14]. However, as a serious drawback, many edible fats contain a high content of fatty acids (FFAs), which increases the cost of producing biodiesel [15]. There are many examples of edible oil plants such as croton tree (*Croton macrostachyus*), jatropha tree (*Jatropha curcas*), castor bean seed (*Ricinus communis*), neem (*Azadirachta indica*), tobacco seeds (*Nicotiana tabacum*), moringa tree (*Moringa oleifera*), yellow thistle seeds (*Argemone mexicana*) rice bran, etc. The type and amount of fatty acids contained in vegetable oils depends on the type of plant and the growth conditions of the plant.

Croton macrostachyus: In Ethiopia, *croton macrostachyus* occurs in regions between 1300 and 2500 m a.s.l (another study reports range 500-3400 m a.s.l), with an annual rainfall of between 750 and 2000 mm. The tree is common in lowland forests, forest edges, rivers, lakes, dense jungles and evergreen forests, forests, grasslands or dense forests and along roadsides. *Croton macrostachyus* is a member of the family *Euphorbiaceae* [16,17]. It is the first effective solution for *croton macrostachyus* as a new biodiesel stock, producing an oil yield of 53.34%. To date *croton macrostachyus* 'baby is widely used as a tool to prevent soil erosion, maintain soil fertility and the source of traditional medicine for diseases such as skin diseases and rabies.

Jatropha curcas: *Jatropha curcas* is a small tree or shrub, up to 5-7 m tall, belongs to the family *Euphorbiaceae* [18]. It is a drought-tolerant plant that can survive in abandoned and cultivated areas [19]. It is a tropical plant that thrives in temperate climates with a rainfall of 250-1200 mm. It is well adapted to desert and desert conditions and has a low need for fertility and moisture. It can also grow in medium sodic and saline soils, degraded and eroded. The ideal crop density per hectare is 2500. It produces seeds after 12 months and reaches its maximum production in five years and can live for 30 to 50 years. Seed production ranges from 0.1 tha-1 y-1 to more than 8 tha-1 y-1 depending on soil conditions [20]. Depending on the variety, Jatropha ornamental seeds contain 43-59% of fat [21].

Moringa oleifera: *Moringa oleifera* is a member of the *Moringaceae* family, grows in many tropical climates, is drought tolerant and can survive in harsh, poor and barren soils. *Moringa oleifera* oil contains a high oleic acid content of about 70% of its fatty acid profile [22]. This plant begins to reproduce Pods 6-8 months after planting and reaches an average of 3 tons of seed per hectare per year. Seeds contain an average of 40% fat by weight [22].

Ricinus communis* (Castor)*: *Ricinus communis* belongs to the family *Eurphorbiaceae* and is also known as castor bean. It is an edible oil seed plant that is easily grown and drought tolerant [23]. Its oils are viscous, fragrant, pale yellow, durable and non-greasy with a hint of flavor and are sometimes used as a cleanser. On average, seeds contain about 46%-55% of fat [24].

Azadirachta indica* (Neem)*: The *Azadirachta indica* (Neem) tree belongs to the *Meliaceae* family. It is a versatile tree and is a evergreen tree, 12 to 12 feet (12-18 m) tall, that can grow in almost all types of soils including clay, salty, alkaline, dry, rocky, and shallow, even in strong, calcareous soils. It thrives in arid and semi-arid areas with shade temperatures reaching 49°C and rainfall at 250 mm. It can be grown by sowing seeds directly or by planting seedlings raised in kindergarten in the rainy season. It reaches maximum production after 15 years and has a life expectancy of 150-200 years. Planting is usually done at a rate of 400 plants per hectare. Neem oil production varies greatly from 2-4 ton/ha/year and the mature Neem tree produce 30-50 kg fruit. Fruit seeds contain 20-30 wt% fat and seeds contain 40-50% green to brown oil [25].

Rice bran*:* Rice bran is a cuticle between paddy husk and rice grains and is found as a by-product in the production of refined white rice from brown rice. Bran is very nutritious due to the presence of lipids, proteins, minerals and vitamins. It is extracted from white rice bran where rice composition varies with rice type, weather conditions and rice processing methods [26]. The fat content of rice bran varies from 12%-25% [27]. The high FFA content of rice bran oil makes it unsuitable for food purposes. The estimated yield of crude rice oil is 8 million metric tons if all the rice bran produced in the world were not bound to extract oil. Rice bran oil is an inedible vegetable oil, widely available in rice-growing countries, and little research has been done to substitute this oil for mineral diesel [28].

Nicotiana tabacum* (Tobacco)*: *Nicotiana tabacum*, commonly referred to as tobacco, is a product that contains a large amount of fat (35%-49% by weight) with an average annual yield of 15,000 tons per year. The tree is often planted to collect leaves [29]. Cholesterol triglyceride is a non-dairy product, chemical and thermal compounds that are comparable to other vegetable oils and have the potential to be considered a new biodiesel-producing stock [30].

Argemone mexicana: Its common name is Mexican prickly poppy belongs to the *Papaveraceae* family. The plant prefers light (sandy) soils, requires well-drained soil and can grow in nutritionally poor soil. The seeds contain 22-36% of pale yellow non-edible oil called argemone oil or katkar oil. The main fatty acids present in *Argemone mexicana L.* seed oil are myristic acid, palmitic acid, stearic acid, oleic acid, linoleic acid and arachidic acid. The non-edible oil from this tree has been found suitable for biodiesel purpose [31].

Advantages of non-edible oils: Preliminary evaluation of several non-edible oilseed crops for their growth, feedstock and adaptability show that these feedstocks have the following advantages [21,32].

- The adaptability of cultivating non-edible oil feedstocks in marginal land and non-agricultural areas with low fertility and moisture demand.
- They can be grown in arid zones (20 cm rainfall) as well as in higher rainfall zones and even on land with their soil cover. Moreover, they can be propagated through seed or cuttings.
- They have huge potential to restore degraded lands, create rural employment generation and fixing of up to 10 ton/ha/year CO_2 emissions.
- They do not compete with existing agricultural resources.
- They eliminate competition for food and feed. Non-edible oils are not suitable for human food due to the presence of some toxic components in the oils.
- They are more efficient and more environmentally friendly than the first generation feedstocks. Conversion of non-edible oil into biodiesel is comparable to conversion of edible oils in terms of production and quality.

- Less farmland is required and a mixture of crops can be used. Non-edible oil crops can be grown in poor and wastelands that are not suitable for food crops.

- Non edible feedstock can produce useful by-products during the conversion process, which can be used in other chemical processes or burned for heat and power generation. For instance, the seed cakes after oil expelling can be used as fertilizers for soil enrichment.

- Most of non-edible oils are highly pest and disease resistant.

- The main advantages of non-edible oil are their liquid nature portability, ready availability, renewability, higher heat content, lower sulphur content, lower aromatic content and biodegradability.

Biofuel and environmental concern: Assessing the long-term natural impact of the production of biodiesel feed-stocks is a daunting task. In addition, deforestation allows biofuel crops and loss of forests; peat areas and grasslands can actually exacerbate global warming and climate change [33].

Due to environmental considerations, biodiesel is considered carbon neutral because all the CO_2 released during use was taken up into the atmosphere to grow oil plants. Biodiesel combustion has been reported to emit fewer pollutants in the environment compared to diesel [34]. This indicates that the engine exhaust does not contain SO_2, and indicates the release of PAH, CO, HC, soot and aromatics. NO_x emissions are reported to be relatively low compared to diesel depending on engine combustion features. The practice of planting energy plants in remote areas has become an important area of research, especially as concerns about food security and biodiversity grow.

In addition to contributing to GHG production, biofuel-driven agriculture can also lead to land use disputes between different stakeholders. Recently, KOH [35] investigated the possible loss of habitats and biodiversity that could result from an increase in biodiesel production capacity to meet future biodiesel needs (estimated 277 million tons per year by 2050). The demand for biofuels and the impact from food costs may have a direct impact on forests and biodiversity by undermining new systems driven by conservation motives.

Future direction: Planting biofuel production plants in low-income farming areas will increase food and fodder prices. This situation will be particularly acute in poor countries and in less developed agricultural areas. Considering all these factors, the only way out of this crisis is to identify the most promising plant species and to reproduce new-borns in abandoned and degraded soil to improve their ability to build biomass. Encouraging the cultivation of non-edible oil seed crops not only allows for the use of the soil but at the same time it is also used to produce oil plants for biodiesel production without the need to compete with food crops in a limited agricultural environment. Considering all these factors, non-edible fats are definitely beneficial to edible fats such as biodiesel feedstock. The ideal solution would be an equal share provided with edible fats and non-edible fats. Fertile agricultural land should remain for edible oil production while the desert or non-fertile area should be planted with inedible oil plants with simple natural needs. This will allow for better use of limited land areas, especially in developed countries. Different biodiesel feedstock resources will also ensure that the available biodiesel level is appropriate for that area.

CONCLUSION

The demand for biodiesel worldwide is expected to increase sharply in the near future. Competition of edible oil sources as food *vs.* fuel makes edible oil not an ideal feedstock for biodiesel production. Although rush to energy crops, either food or non-food crops, threatens to cause food shortages and damage to biodiversity with partial benefits. Moreover, diversion of land from food or feed production to energy biomass production will influence food prices. Non-edible plant oils are unsuitable for human food because of the presence of some toxic components. These plants are easily available in developing countries and are very economical comparable to edible plant oils. Biodiesel produced from non-edible plant oils has good potential as an alternative diesel fuel.

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