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Review Article

Madhuca indica seeds: A Potential Source for Industrial Production of Biodiesel

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Abstract

The rapid urbanization due to fast industrialization and increase in population led high demand for energy. Due to increased demand for energy, an alternative source of energy has been explored by scientist in different country around the globe. India is a vast agro-forestry country, fuels of biological origin from non-edible agricultural products is an ideal alternative source of renewable energy. Various renewable feedstocks have been identified for production biodiesel which includes edible oils, non-edible oils, algal oils, wild oils, waste cooking oil and animal fats. *Madhuca indica* is forest based tree grows in dry land with minimal water. Its non-edible seeds contains high amount of fatty acids, thus it found to be a potential source for biodiesel production. Annual production of *Madhuca indica* seeds is about 60 million tons in India. Thus the dry and waste land can be reforested by *Madhuca indica* trees for increased production of its seeds and can be utilized for commercial production of biodiesel.

Keywords: *Madhuca indica*; Biooil; Biofuels; Renewable energy; Biodiesel.

Introduction

Energy consumption is increasing in very high rate due to modern life style and the significant of population growth. The increase in energy consumption is supplied by fossil resources, which causes crises for fossil fuel due to fast depletion. Increase in price of fossil fuel and the serious environmental impacts are other major issues. Fossil fuels have limited sources of energy. Energy is in high demand in today's world. The utilization of non-renewable energy sources posed a threat towards fossil fuels. The ever increasing oil prices, depleting oil reserves and fossil fuels hurdles the development of countries the world looks for alternatives. This created a challenge and opportunity to search for replacement of fossil fuels for socio-economic benefits. This leads to search for economically efficient, socially equitable and environmentally sound alternative sources of energy [1,2]. Biofuels found as best alternate solution to substitute to fossil fuels. Bioresources used biofuels production are sustainable and cost wise competitive with fossil fuels. Biofuels are more environmental friendly and accessible to distribute. Extensive research has been carried out and alternative fuels like biodiesel, bio-alcohol and other biomass sources prove positive results [3,4].

The transportation sector consumes 30 % of the world's total energy and is the reason for almost 60 % of the world's oil demand. It has been marked as the largest energy-consuming sector after the industrial sector and in the future will turn out to be the most-energy demanding sector of the world. Usage of renewable biological sources for bio-oil production as an alternative to pollution causing fossil fuels like coal, petroleum, diesel etc., proves to be successful. The one drawback of choosing renewable biological sources like plant, microbial cells, biomass, edible and non-edible seeds, is its availability and cultivation on agricultural lands that requires time and sustainable physiological conditions. However production of biooil from renewable sources decreases cost of production by 60-90% compared to the energy production from fossil sources [5,6].

Biofuels are made from renewable biomass. They have enormous potential and can meet the current world energy demand, when efficient technologies are developed. Future targets and investment plans on biofuels technologies suggest strong growth in near future. The potential use of biofuels will be enormous from an economic, political and environmental perspective.

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Sources of non-edible oils as biofuel

Biofuels produced from edible sources account for more than 95%. The conversion of edible plant source to biofuel, leads to risk of utilization of food resources. This leads to increase demand and cost of edible pants. This causes a high imbalance in supply of oil food crops for human consumption and rise in demand for oil food crops in the market. Environmentalists and social scientist have started debate on the negative impact of biofuel production from edible oil sources. They listed the following reasons such as non-availability of good quality planting materials and seeds, seasonal availability planting materials and seeds, unpredictable and inappropriate marketing channels, lack of efficient harvesting technologies and post processing, irregular and low prices, decrease in actual production compared to potential production, absence of government incentives for promoting biofuels, collection from different location, high expectancy, problems harvesting in agricultural lands and forest. This led to the increase in of oil crop cultivation for biofuel production on large scale. This has increases deforestation in several countries like Malaysia, Indonesia and Brazil. The association between food and fuel industries has been disturbed as both industries are striving against fuel sources. Arable land has to be used to grow food instead of growing fuel. But there is always an arising need to choose bio resources for the purpose of bio fuel production. Development of non-edible oil seeds as renewable and alternative feedstock for biofuels are critical towards achieving high self-reliance energy security. Hence the choice has to shifter from using edible to non-edible sources for oil extraction. Thus there arises the need to rely and depend on non-edible seeds for production of bio fuel [6-9].

Advantages of biooil from non-edible seeds

Vegetable oils (both edible and non-edible) are promising feedstocks for the production of biofuels production, since they are renewable and can be produced in large scale. Advantages of biooil from non-edible seeds are availability of non-edible seeds and its easy cultivation on tropical lands due to its adaptation to physiological conditions, biodiesel is produced by trans-esterification of biooil from non-edible seeds, biofuels are bio-degradable and non-toxic in nature when compared to fossil fuels. Non-edible oil crops have large potential to restore uncultivable lands, generates rural employment for farmers and fixing of up to 10 tons/hectare/year CO_2 emissions. The non-edible vegetable oils such as *Azadirachta indica*, *Madhuca indica*, *Jatropha curcas* and *Pongamia pinnata* are found as suitable for biofuels production [10-13]. Various sources of non-edible oil are listed in Table 1.

Table 1. Various sources of non-edible oil

Sl. No.	Non-edible oil source
1.	*Jatropha* seeds
2.	Ricinus communis *seeds*
3.	*Pongamia pinnata* seeds
4.	*Madhuca indica* seeds
5.	*Simarouba* seeds
6.	*Cordia myxa* seeds
7.	*Catharanthus roseus* seeds
8.	*Thespesia populne*a seeds
9.	*Solanum nigrum* seeds
10.	*Thevetia peruviana* seeds

Madhuca indica

Madhuca indica belongs to the Sapotaceae family and grows up to approximately 20 m in height. *Madhuca indica* is adapted to arid environments [10]. *Madhuca indica* trees are found large numbers in India especially in tribal and forest regions. Kernels of *Madhuca indica* seeds were estimated to produce nearly 35 to 45% of oil depending upon the growth and geographical conditions. *Madhuca indica* is highly viscous at room temperature**.** The *Madhuca indica* tree starts yielding seeds after 3-5 years and continues up to 60 years. The kernel of *Madhuca indica* seed contains about 70% of the seed. Each *Madhuca indica* tree can yield around about 20-40 kg of seed per year depends on maturity and size of the tree. Total oil yield is around 2.7 tons per year per hectare [10,13]. *Madhuca indica* fruits in tree branches and seed are shown in fig. 1.

Availability and Distribution of *Madhuca indica*

Madhuca indica tree is native to dry region of India. *Madhuca indica* is the forest based tree, gives non-edible oils with large production capacity of around 60 million tons per annum in India. *Madhuca indica* is a multipurpose tree, found in tropical and subtropical areas of North and Central part of India [10]. In India this tree is found in the

forests of western India from Konkan southward to Kerala. *Madhuca indica* trees are widely grown in Uttar Pradesh, Madya Pradesh, Gujarat and in south India, three district of Karnataka and Monsoon forest of western Ghats in south India. *Madhuca indica* seeds are de-shelled by pressing and dried to get the kernel [14,15]. *Madhuca indica* seed oil have been reported for conversion into biodiesel by transesterification using two-step acid alkaline catalyst [16] and manganese doped zinc oxide nanocatalyst [14].

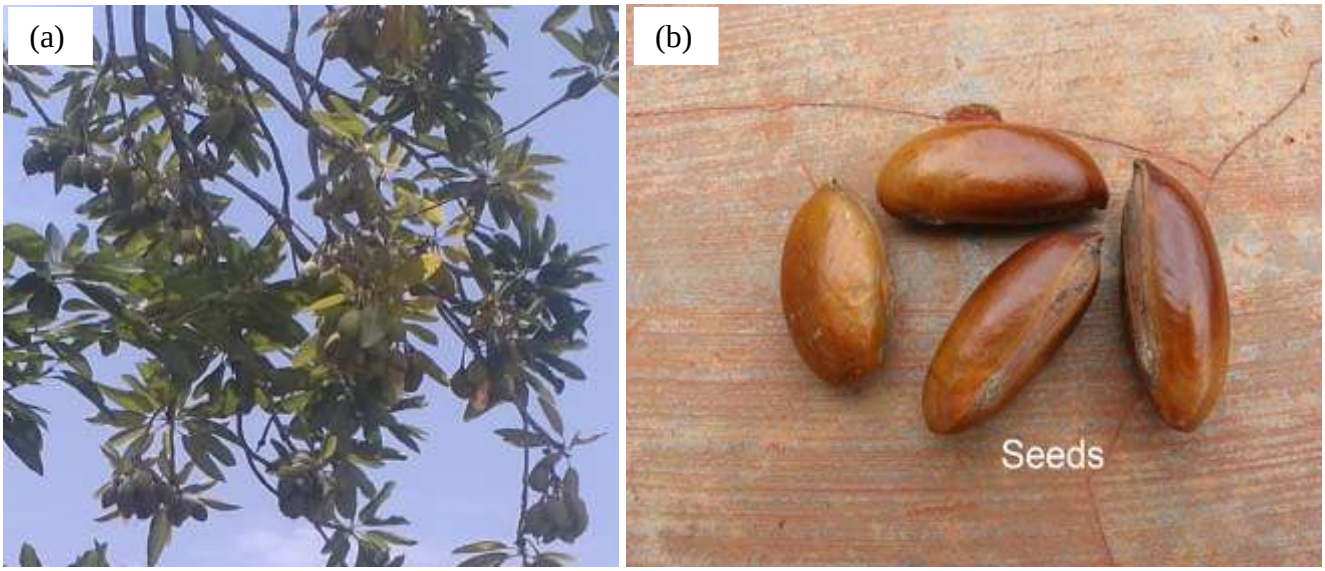

Fig. 1. *Madhuca indica* (a) fruits in tree branches and (b) seeds

Conclusions

Non-edible oil sources are best alternation for use of edible oils form plant sources. The unfertile, dry and waste land areas can be utilized for cultivation of non-edible oil crops to meet the demand for non-edible oil sources to replace use of edible oils. Thus food security can be ensured. Non-edible oil crops will be better alternate as renewable energy to replace fossil fuels.

Conflicts of interest

Authors declare there are no conflicts of interest.

References

[1] IEA (International Energy Agency. France: 2008.

[2] Demirbas A. Future energy systems. Energ Source Part A 2016;38:1721-29.

[3] Antony RS, Robinson SD, Lindon RLC. Biodiesel production from jatropha oil and its characterization. Research Journal of Chemical Sciences 2011;1:82-7.

[4] Scholz V, da Silva JN. Prospects and risks of the use of castor oil as a fuel. Biomass Bioenerg 2008;32:95-100.

[5] Alex T, Vijay BK, Indra NP, Yael KT, Yaron Y, Aharon G. *In-Situ* transesterification of *Chlorella vulgaris* using carbon-dot functionalized strontium oxide as a heterogeneous catalyst under microwave irradiation. 2016;*30*(12):10602–10.

[6] Kumar A, Sharma S. Potential non-edible oil resources as biodiesel feedstock: an Indian perspective. Renew Sustain Energy Rev 2011;15(4):1791-800.

[7] Raj FRMS, Sahayaraj JW. A comparative study over alternative fuel (biodiesel) for environmental friendly emission. Proc. Recent Advances in Space Technology Services and Climate Change. 2010:80-86. DOI:10.1109.(RSTS&CC).5712805.

[8] Pinzi S, Garcia IL, Gimenez FJL, Castro MDL, Dorado G, Dorado MP. The ideal vegetable oil-based biodiesel composition: a review of social, economical and technical implications. Energ Fuel 2009;23:2325–41

[9] Baskar G, Roselin Nivetha S, Mohanapriya N, Asiwarya R. Non-edible oil seeds: Potential source for biodiesel production. International Journal of Industrial Engineering 2017;1(6):183-7.

[10] Atabani AE, Silitonga AS, Ong HC, Mahlia TMI, Masjuki HI, Badruddin IA, Fayaz H. Non-edible vegetable oils: A critical evaluation of oil extraction, fatty acid compositions, biodiesel production,

characteristics, engine performance and emissions production. Renew Sustain Energy Rev 2013;18:211-45

[11] Meher L, Dharmagadda V, Naik S. Optimization of alkali-catalyzed transesterification of *Pongamia pinnata* oil for production of biodiesel. Bioresour Technol 2006;97(12):1392-7.

[12] Moka S, Pande M. Alternative fuels: an overview of current trends and scope for future. Renew Sustain Energy Rev 2014;32:697-712.

[13] Baskar G, Naveenkumar R, Mohanapriya N, Roselin Nivetha S, Aiswarya R. Optimization and kinetics of biooil extraction from *Madhuca indica* seeds, Industrial Crops and Products 2018;124:954-9.

[14] Hariram V, Vagesh S. Characterization and optimization of biodiesel production from crude *Mahua Oil* by two stage transesterification'. American Journal of Engineering Research 2011;3(11)233-9.

[15] Baskar G, Gurugulladevi A, Nishanthini T, Aiswarya R, Tamilarasan K. Optimization and kinetics of biodiesel production from mahua oil using manganese doped zinc oxide nanocatalyst, Renew Energ 2017;103:641-6.

[16] Ghadge SV, Raheman H. Biodiesel production from mahua (Madhuca indica) oil having high free fatty acids. Biomass Bioenerg 2005;28(6):601–5.

[17] Jena PC, Raheman H, Prasanna GVK, Machavaram R. Biodiesel production from mixture of mahua and simarouba oils with high free fatty acids. Biomass Bioenerg 2010;34(8):1108-16.

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