Open Access Research Journal of
Science and Technology
Journals home page: https://oarjst.com/
ISSN: 2782-9960 (Online)

(REVIEW ARTICLE)

Biofuel from biomass as an alternative energy source for sustainable development

Santosh Narayan Chadar [1,*] and Anil Kumar Ahirwar [2]

[1] *Department of Chemistry, Government Shayam Sundar Agrawal PG College, Sicora, Jabalpur (M.P), India.*
[2] *Department of Chemistry, Government College Bichhua, Chhindwara (M.P.), India.*

Open Access Research Journal of Science and Technology, 2022, 06(01), 071–074

Publication history: Received on 18 December 2021; revised on 31 January 2022; accepted on 02 Februay 2022

Article DOI: https://doi.org/10.53022/oarjst.2022.6.1.0023

Abstract

Energy is a critical input for economic growth and sustainable development in both developed and developing countries. The world's energy requirement for transportation is met from non-renewable fossil fuels. Two hundred years ago, the world experienced an energy revolution that launched the industrial age .The industrialized world's thirst for energy has increased tremendously which caused a serious energy crisis. Biodiesel production from different vegetable oils is a promising alternative fuel for the diesel engine and as a major step towards creating an environment friendly transportation fuel that is relatively clean on combustion. This paper deals with the biofuel as an alternative fuel derived from biomass, namely ethanol and biodiesel. The paper discusses how the potential of biofuel offsets the use of fossil fuels and reduces the emission of green house gases, it also lays emphasis on the environmental impact of Jatropha curcas a plant species which is used for biofuel production and how biofuels improves air quality.

Keywords: Biodiesel; Biofuel; Biomass; Energy source; Alternative fuel; Air quality; Jatropha curcas

1. Introduction

Biofuel is a fuel which is produced through contemporary processes from biomass, rather than by a very slow geological processes involved in the formation of fossil fuel such as oil. Other than the alternative fuel for diesel fuel which is used for the transportation purpose, biofuel provides hydrogen, cleans up the oil , can be used as cooking oil etc. Biomass can easily be directly converted into liquid fuels called biofuels which is used as a fuel in transportation. Ethanol and biodiesel are most common biofuels used today. Some of the common biofuels include:

- Ethanol (made from corn in the U.S & Sugarcane in brazil).
- Biodiesel (from vegetable oil & liquid animal fat)
- Green diesel (made from algae & other plant sources)
- Biogas (methane derived from animal manure and other digested organic material.

Ethanol is a renewable fuel that can be made from various plant materials, collectively known as biomass. Ethanol is an alcohol used as a blending agent with gasoline to increase octane and cut down carbon monoxide and other smog causing emissions. The most common blend of ethanol is E10 (10% ethanol, 90% gasoline). Some vehicles, called flexible fuel vehicles, are designed to run of E85 (a gasoline-ethanol blend containing 51%-83% ethanol, depending on geography and season), an alternative fuel with much higher ethanol content than regular gasoline. Roughly 97% of gasoline in US contains some ethanol .Most ethanol is made from plants, starches and sugars, but scientists are continuing to develop technologies that would allow for the use of cellulose and hemicelluloses, the non-edible fibrous material that constitutes the bulk of plant matter. In fact, several commercial- scale cellulosic ethanol biorefineries are

* Corresponding author: Santosh Narayan Chadar
Department of Chemistry, Government Shayam Sundar Agrawal PG College, Sihora , Jabalpur (M.P), India.

currently operational in US. The most common method for converting biomass into ethanol is called fermentation. During fermentation, microorganism like bacteria and yeast metabolize plant sugars and produce ethanol.

Biodiesel is a liquid fuel produced from renewable sources, such as vegetable oils and animal fats and is cleaner burning replacement from petroleum based diesel fuel. Biodiesel is non toxic and biodegradable and is produced by combining alcohol with vegetable oil or animal fat. Like petroleum derived diesel, biodiesel is used to fuel diesel engines. Biodiesel can be blended with petroleum diesel in any percentage, including B100 (pure diesel) and, the most common blend, B20 (20% biodiesel & 80% petroleum diesel).Biodiesel is a renewable biodegradable fuel manufactured domestically from vegetable oils or animal fats. Biodiesel meets both the biomass based diesel and overall advance biofuel requirement of the renewable fuel standards. Biodiesel is a fuel often referred to as B100 or neat biodiesel in its pure, unblended form. Like, petroleum diesel, biodiesel is used to fuel compression ignition engines. Biodiesel performance in cold weather depends on the blend of biodiesel, the feedstock, and the petroleum diesel characteristics. In general, blends with smaller percentages of biodiesel perform better in cold temperatures.

1.1. Biofuel Resources

Biofuel is most commonly defined as a renewable source of energy which is produced from biological materials or biomass, such as sugarcane, corn or vegetable oil. The strategic goal of biofuel is to supplement or even replace fossil fuels. India has a plethora of species that can be used, produce from conventional oil seeds, woody materials, and wastes from agriculture and municipal solids. There are over 300 oil seeds bearing tree species in India. India is rich in biomass and majority of Indian population used biofuels traditionally but in many cases inefficiently which led to a couple of major social problems particularly health effects of air pollution. Appropriate technology for making biofuel available to the people and its effective utilization would have significant impact on India's socio economic conditions.

Production technologies of biofuels includes

1.1.1. Conversion of biomass to biofuels

- Using mechanical processes such as extraction for biodiesel and compression for pelletization.
- Using chemical processes such as liquefaction, hydrolysis, gasification etc.
- Using bacteria i.e, biogasification through biomethanisation.
- Using algae for conversion of micro-algal biomass to biofuels.

1.1.2. Accumulation of wastes

1.1.3. Energy plantation.

Some of the Utilization technologies of biofuel includes

- Direct burning, combustion or gasification for heating or power generation.
- Biogas for cooking or fuel cells for power generation or co-generation.
- Transport fuel.

1.2. Processes of Biofuel Conversion

High temperature deconstruction and low temperature deconstruction are the two deconstruction processes which are used to produce advanced biofuels. Cellulosic ethanol and renewable hydrocarbon fuels are formed by use of extreme heat and pressure to break down solid biomass into liquid or gaseous intermediates through pyrolysis, gasification and hydrothermal liquefaction.

Low temperature deconstruction uses biological catalyst called enzymes or chemicals to breakdown the feedstock into intermediates by the process called hydrolysis. Following deconstruction, intermediates such as crude bio-oils, sugars, syngas and various other chemical building blocks has to be upgraded to produce a finished product through biological or chemical processing.

There are number of routes to produce biofuels from biomass , they are summed up below:

1.2.1. Biodiesel

Vegetable oils from food (first generation) and non food (second generation) sources, such as jatropha and karanja can be converted to biodiesel. The main conversion is through trans-esterification where the oil is mixed with alcohol and an alkaline catalyst to produce a fatty acid methyl- ester which has properties similar to fossil fuel diesel. India's policy is to use second generation plus waste vegetable oil. It is three times cheaper as a feedstock and can yield a quality biodiesel with a lower pollution potential.

Table 1 Selected biomass to biofuel routes

Resources	Technology	Product	End use
Algae, oil seeds	Trans-esterification	Biodiesel	Diesel engine
domestic waste, algae, cattle slurry	Anaerobic digestion	Biogas	Gas or petrol engine if gas to liquid .Fischer tropsch reaction
agricultural waste, wood, municipal waste.	Gasification	Syngas	Gas or petrol engine
Cellulosic biomass	Fermentation	Ethanol	Petrol engine

1.2.2. Bioethanol

Unlike biodiesel, bioethanol can be divided into ethanol derives from food (first generation) and non-food (second generation sources). India produces 1.3 billion litres of ethanol from cane molasses. India is now adopting a new policy for ethanol production from cellulosic biomaterials. Sugarcane and wheat are the major feedstock for biofuel production in India. Globally many cellulosic agro- residues have been used to produce bio-ethanol such as rice straw, wheat straw, sugarcane bagasse, sugarcane tops, cotton stalk, soft bamboo, bamboo processing wastes etc are abundantly available feed stocks. In india, cashew apple pulp, coffee pulp, and banana peels are also used.

2. Impact of biofuel production on environment (Jatropha curcas)

One of the plant species that is being studied extensively for biofuels production is Jatropha Curcas. The biofuel produced from the jatropha seeds can be a alternative to fossil fuel thereby reducing the green house gases emission. Cultivating jatropha on arid and unusable lands prevents desertification of the land. Research also showed that jatropha cultivation can be used for carbon sequestration. However, the water requirements were still unclear and could be low to high depending on the specific variety that is being used. Jatropha cultivation on large scale could also lead to eutrophication. The potential for using jatropha for sustainable environmental development has identified several of its benefits. Jatropha bioaccumulation potential allows it to be used for the phytoremediation of polluted soil while producing biodiesel. Biofuels are carbon neutral making them a good renewable energy source. When compared to fossil fuels, biofuels reduce CO_2 emission along with the reduction in SO_2, ozone forming chemicals, trace gases that cause air pollution and toxic heavy metals. Jatropha plantation also helps in the mitigation of soil erosion due to taproot stabilization. It can also be used for reforestation in arid areas, management to marginal land, help in water and soil conservation, prevent wind erosion and for stabilization of sand dunes. One of the advantages of using jatropha is that its cultivation helps in re-vegetation of degraded land and there is no competition for arable land that used for food crops. Another advantage of using jatropha plant is that once the seed is processed and the oil is extracted the remaining seed meal can be used to produce biogas or the remaining seed cake can be used as manure.

3. Biofuel for improvement in Air Quality

Biofuels have emerged as one of the most strategically important alternative fuel sources and are considered an important way of progress for limiting green house emissions, improving air quality and finding new energetic resources. Biofuels burn cleaner than fossil fuels. They don't produce sulphur or aromatics, so there is no unpleasant smell associated with burning biofuels. They still release greenhouse gases like carbon dioxide but at reduced level. It reduces danger of environmental disaster .Biofuels are non polluting, locally available , accessible and reliable fuels obtained from renewable sources. Biomass can act as reserviour of carbon or as a direct substitute for fossil fuel with no net combustion to atmospheric carbon dioxide if produced and used sustainably.

4. Conclusion

It is concluded that biofuel burn cleaner than fossil fuel. Biodiesel and Ethanaol production from vegetable oil is promising alternative fuel for the diesel engine which is relatively clean on combustion. Biofuels offsets the use of fossil fuels and reduce the emission of green house gases. Biofuel reduces carbon dioxide emission, along with reduction in sulphur dioxide, ozone forming chemicals, trace gases that causes air pollution and toxic heavy metals. It also improves air quality. Hence, we can say that Biofuels from biomass ia an alternative energy source for sustainable development.

Compliance with ethical standards

Acknowledgment

I acknowledge the Departmental Library of Government SSA PG College, Sihora, Jabalpur and Library of Regional Institute of Education, Bhopal for providing sufficient resources to carry forward the study.

Disclosure of conflict of interest

The authors have no conflicts of interest to report.

References

[1] Altenburg T, Dietz H, Hahl M, Nikolidakis N, Rosendahl C, Seelige K. Biodiesel in India- value chain organization and policy options for rural development German development institute, Bonn, Germany. 2009.

[2] Bandyopadhyay KR. Policy brief on biofuels promotion in India for transport: Exploring the grey areas, The energy research institute, New Delhi. 2015.

[3] Bhatia L, Paliwal S. Banana peel waste as substrate for ethanol production. Int J Biotechnol and Bioeng Res. 2010; 1(2): 213-8.

[4] Bryant C. India-an emerging market for cellulosic bioethanol. Biofuel. 2009; 78-9.

[5] Cetinkaya M, Karaosmanoglu F. Optimisation of base-catalysed transesterification reaction of used cooking oil. Energy Fuels. 2004; 18: 1888-95.

[6] Encinar JM, Gonzalez JF, Rodriguez-Reinares A. Biodiesel from used frying oil. Variables affecting the yield and characteristics of the biodiesel. IndEngChemRes. 2015; 44: 5491-9.

[7] Gunatilaake H. India: Study on cross sectoral implications of biofuel production and use, Asian development bank, Manila. 2011.

[8] Nas B, Berktay. A Energy potential of biodiesel generated from waste cooking oil: An environmental approach. Energy Sources. 2008; 2: 63-71.

[9] Pandey VC, Singh K, Singh JS, Kumar Akhilesh, Singh Bajrang, Rana P, Sinngh. Jatropha curcas: A potential biofuel plant for sustainable environmental development, Renewable and Sustainable energy reviews. 2012; 16: 2870-2883.

[10] S Prasad, MS Dhanya, N Gupta, A Kumar. Biofuel from biomass: A sustainable alternative to energy and environment. Division of environmental sciences, Indian A gricultural Reasearch Institute, New Delhi. 2012.

[11] Shenoy D, Pal A, Vikas RK, Neeraja HS, Deeksha JS, Naya KC. A study on bioethanol production from cashew apple pulp and coffee pulp waste.Biomass Bioenergy. 2011; 35: 4107-11.

[12] Timilsina GR, Shreshtha A. How much hope should we have for biofuels? Energy. 2011; 36: 2055-66.

[13] Utlu Z. Evaluation of biodiesel obtained from waste cooking oil. Energy Sources, Part A. 2007; 29: 1295-304.

[14] Zhang Y, Dube MA, McLean DD, Kates M. Biodiesel production from waste cooking oil: Economic assessment and and sensitivity analysis. Bioresour Technol. 2003; 90: 229-40.