Section: Research Paper

Biofuels as an opportunity to sustainable energy

Alexius Lakra[a] , Sarvaree Bano[b*]

[a b] Department of Chemistry, Kalinga University, Naya Raipur-492101, Chhattisgarh, India

e-mail. id – Sarvaree.bano@kalingauniversity.ac.in

Abstract

One among the key ingredients in the development of every nation's economy is energy. For emerging nations, economic expansion is desirable, and energy is necessary for economic progress. Most important world economies, and also big consumers of fuels from fossils, have been obliged in order to look into renewable as well as less expensive energy sources to suit their needs due to the rise in the expense of fuels from fossils on a global scale. The relevance of biofuels (biodiesel and ethanol) is developing quickly along with rising concern over the supply of crude oil and rapid climatic changes. A safe and healthy fuel is biodiesel. Biodiesel is a fuel which is procured from plants or animal fats that are both edible and inedible. It doesn't need to be modified for usage in our diesel engines currently. It can be combined with the remaining diesel and petroleum. Biodiesel is interesting since it reduces greenhouse gases by 78%. Due to their quality ingredients matching diesel and gasoline, respectively, bio-ethanol as well as diesel has appeared to be the upmost viable renewable fuel and serve as substitute to fossil fuel. They also produce less pollution than their rivals who use fossil fuels. Worldwide efforts to produce ethanol derived from sources such as plants that produce sugars and starch and biodiesel from vegetable oils have increased because to concerns with the environment and We must cease consuming petroleum if we want to stay alive on this earth, as it is heating up. People are testing out different ways to halt global warming around the world to see which ones are most effective. Nearly all countries favor biodiesel as their fuel of choice.

Keywords: Bio-fuels; Bio-diesel; Energy safety; Environmental Sustainability; Ethanol.

1.Introduction

The urgent need for alternative fuel sources has been justified by the world population's rapid growth, ongoing energy crises, the rapidly declining state of non-renewable energy sources, the explosive growth in vehicle use, the pollution risks posed by fuel emissions, and the associated health problems. For the following two decades, it is anticipated that the demand for energy will continue to rise. Fossil fuels, such as petroleum products, coal, and natural gas, presently encounter the major needs of the world's energy requirements. The need for these alternative fuels emerged as a result of the realization that the world's supply of fossil fuels is extremely limited and that burning them causes a number of additional environmental issues, including global warming. Emissions of greenhouse gases are greatly increased when conventional fuels like petroleum are burned. The most effective approach to lower greenhouse gas emissions is through biofuels. They are understood to be a kind of energy safety that serves as a substitute to fuels obtained from

fossils, which have a inadequate supply. The usages of biofuels have grown recently all across the world [1-5].

1.1 Biofuels

Biofuels are liquid fuels which might be sustainable and made from organic raw substances. They have got proven to be effective alternatives to oil in the transportation zone. As an end result, biofuels like ethanol and biodiesel are becoming more and more popular all through the arena as an option to troubles like environmental degradation, strength security, restricting imports, rural jobs, and agricultural financial system. As a fuel or an oxygenate for gasoline, ethanol is utilized. Several raw materials are used to produce ethanol, including sugars in Brazil, cereals in the United States, beetroot sugar in Europe, and molasses in India. Any carbon source can readily be used to make biofuels, making photosynthetic plants the most popular source of carbon. Two approaches are now being used to address the aforementioned issues. In the first, starch or sugar crops are farmed, and ethanol is created through fermentation. Plants that naturally yield oils are grown in the second technique. These oils are heated to make them less viscous before being utilized directly as diesel engine fuel. It is possible to further process this oil to create biodiesel, which has a variety of uses. The majority of biofuels come from biomass or biowaste. The majority of biomass are obtained from animals and plants, as well as the waste products [6–12].

1.2 Bio-diesel

It is a sort of energy from renewable sources that may be created through a process called lipid transesterification from several sources, such as oils from vegetables, fats from animals, and oils from algae. It can be used as a full substitute for petroleum-based diesel or as a blend of biodiesel and petroleum because it shares some characteristics with that fuel. One of the most likely possibilities to succeed fossil fuel to be the major source of fuel for transportation is biodiesel because it is a renewable fuel, it is capable to be a substitute petroleum diesel in current engines, which can be carried and wholesaled using the existing infrastructure. Although biodiesel doesn't include any petroleum, it can be mixed with petroleum diesel at any percentage to make a blend of biodiesel or utilized in its clean form. Because biodiesel has characteristics comparable to those of petroleum diesel fuels, it can be used in compression ignition engines without much, if any, engine modification. Since it may be stored similarly to petroleum-based diesel fuel, no additional infrastructure is needed [13, 14].

The burning of biodiesel does not release sulphur dioxide, in contrast to the combustion of fuels from fossils like oils and coal. Compared to conventional diesel, biodiesel exhaust emissions smell significantly better. It additionally has other purifier characteristics which include less carbon monoxide, unburned hydrocarbons and soot particles. Diesel engines are lots more green than petrol engines and so less electricity is wasted if we use biodiesel as opposed to petroleum. Biodiesel can be and is already combined with normal diesel to form biodiesel blends. These blends are already sold at many filling stations. Those blends can be in any share; however you may regularly find five% biodiesel to 95% fossil gas diesel [15].

1.3 Biofuel crops

From starch, juice, or molasses, Jatropha, Sugarcane, Sweet Sorghum, Tapioca, Sugar Beet, Maize, and Pungam produce biofuel [16-18].

1.3.1 Jatropha

A perennial shrub that produces non-edible oil with several uses is called Jatropha curcas. It is a member of the Euphorbiaceous family and is native to Tropical America. Because it makes latex, animals do not browse the plant. It may be grown in marginal terrain with little input because it's robust and drought-tolerant crop. It could be economically maintained for 30 years. There are 476 species in the genus Jatropha, 12 of which are located in India. Jatropha curcas is a promising plant that produces a good amount of seeds and recovers its oil. Jatropha oil can make up to 20% of the biodiesel blend. Nine months after sowing is when flowering begins. Economic yield begins at the conclusion of the third year. Every plant, 3 kilogram of seeds is produced. Glycerin is obtained by processing as seed as a byproduct and is used as an ingredient in medicines, cosmetics, and personal products. It is employed for thickening, lubrication, sweetening, and anti-freezing. It can be used as a solvent, as a medium for dispersion, emollient, plasticizer and many other end uses.

Heat can denature the traces of toxins found in jatropha oil and cake. Due to its toxicity, the oil cake is not safe to be used for animal feed. Oil cake had 4.4, 2.1, and 1.1 percent of NPK content, respectively. One benefit is that jatropha can fix to 10 t/ha of carbon dioxide. About 26 to 36% oil present.

1.3.2 Sugarcane

The Gramineae genus Saccharaum L. has six species of perennial grasses that are used to make sugarcane. A humid or subtropical weather having at least 650 mm of yearly moistness is necessary for sugarcane farming. Nowadays, cane sugar is grown in tropical nations. Cane molasses is a byproduct that is obtained after refining of sucrose's from sugarcanes. A byproduct of the production of cane sugar is molasses. Molasses may be produced from a ton of cane at a rate of about 2.7%. Both cattle feed and fertilizer can be made from molasses. Alcoholic distillate can be created by distilling and fermenting molasses. Their primary uses remain in vinegar, medicines, and cosmetics, solutions used for cleaning, coats and solvents. Lactic acids, Butanol, citric acid (employed for beverages and foods), yeasts and glycerol are further products made from molasses.

1.3.3 Sugar beet

A biennial root crop that produces sugar, sugar beetroot (Beta vulgaris spp.), is planted in temperate regions and accounts for around 24% of global sugar output. The main sources of crystal sugars (white) globally are sugar beetroot and sugarcane. Many tropical locations are seeing an increase in the popularity of tropical sugar beetroot.

Prominence of sugar beet

- Lots of sucrose is present (14 to18 %)
- The harvest occurs during the off-season,
- It fits nicely into the annual crop rotation, and
- It recovers the health of soils.
- Production of ethanol per unit time is high (13,000 to15,000 lts per hectare annually).

1.3.4 Sweet sorghum

For producing grain and cane simultaneously, sugar sorghum, which is recognized as sweet sorghum, is presently being researched. In 1950, it made its debut in the USA. Sweet sorghum, which may be used to make syrup or silage and has a sweet, juicy stem that is high in sugars and sucrose, can also be utilized as feed. The manufacturing of ethanol uses sweet sorghum, which is farmed in Brazil. It is the major source of ethanol in the countries like South Africa, Australia, China, Brazil and USA. Sugar sorghum has a 4000 l/ha possible yield, whereas corn, wheat, and grain sorghum only yield 2291, 916, and 82 l/ha of ethanol, correspondingly. Sweet sorghum's ethanol produce varies by country and is 2640 lit/ha in Brazil, 3001 lit/ha in South Africa, 7001 lit/ha in China, and 4792 lit/ha in the United States (USA). The yield of biomass is 35 to 50 t/ha. An increased produce of sugars, grains, as well as lignocellulosic biomass can be produced from sugar sorghum [19-21].

1.3.5 Cassava

Cassava has a huge potential as a food, feed for animal, and raw materials for industrial uses. Cassava can be employed for production of products of alcohols, dextrin’s, water soluble starch, etc in industrial settings. Approximately 7.5 g of ethanol per 25 g of cassava chips made up the yield of bioconversion.

a. Maize

To make ethanol plants commercially feasible, distillers' dried grains, a byproduct of the production of ethanol from corn, must be sold. The majority of the proteins that are present in corn quickly results in formation of films and is not soluble in water. Zein is the name of this alcohol-extractable protein. The overall cost of manufacturing ethanol should be greatly reduced with sale of isolates of Zein which is a byproduct in the dry gains of distillation, allowing corn growers to gain and sustain greater revenues from components which are non-starch source of corn. In Tamil Nadu, maize is farmed on 2 lakh hectares of land using both irrigation and rainwater.

b. Sweet potato

Nowadays, sweet potatoes are grown everywhere there is enough water for them to grow, including tropical and warm temperate areas. Sweet potatoes are a good source of vitamin A in terms of nutrition, especially those with yellow flesh. The yield in calories/unit area is greater on comparison to maize or potatoes, according to a comparison with other food crops.

The roots are often prepared by boiling, frying, or baking. A partial flour substitute and starch can also be created by processing them.

Table 1: Evaluation of yield of ethanol obtained from different feed stocks.

Source	Name of the Crop	Yield of the crop (t/ha)	Yield of Ethanol (l/t)	Recovery of Ethanol (%)	Potential yield of ethanol (l/ha)
Beet juice	Sugar beet	74 to 80	74 to 90	7 to 9	6755 to 7200
Molasses	Sugarcane	100 to 120	200 to 240	20 to 24	1000 to 1200
	Sweet sorghum	50	40 to 45	44.5	2000 to 2250
	Sweet potato	20 to 25	150	15	3000 to 3500

	Wheat	5	-	-	900
	Sorghum grain	4	-	-	800
Hemicellulose/ Cellulose	Wood chips, Paper, Plant material with fiber	Crop residues and stacks based on glucose			150 to 180 l/t
		Crop residues and stacks based on Xylose			60 to 80 l/t

Starch and industrial alcohol are produced for use in industry. They may also be sliced, fried, and consumed similarly to potato chips. Around 20% starch and 5 to 7% sugars, or a total of 27 to 29% components that are fermentable, are present in sweet potatoes. Around 40 gallons of alcohol's can be made by using a ton of sweet potatoes. A different source of ethanol generation is from sweet potatoes.

2. Bio-ethanol use of ethanol as fuels in vehicles and engines

Alcohols obtained using naturally occurring sugars and plants that have starch, like grains (also referred as grain-alcohol), sugarcanes, and rapeseed oil, is known as ethanol and can be used to power automobile engines. Fermentation and distillation are the techniques used to create ethanol. Occasionally, the term "bioethanol" is used when discussing the use of ethanol as a fuel. The sort of alcohol's which can be consumed as ethanol (like the alcohols in beers and wines). The liquid is clear and colorless with a variety of advantages over gasoline and oil-based diesel fuel [22].

Although on a very modest scale, ethanol is utilized as car fuel in the USA for many years. Governments and energy producers are now forced to take biofuels like biodiesel and bioethanol more seriously due to the recent growth in concerns regarding the adverse effects on environmental due to burning of fossil fuels and the rise in the oil prices. Ethanol is frequently added to regular petroleum to create ethanol-blended gasoline. These blends typically contain 10% ethanol and 90% petroleum, although lately, larger ethanol concentrations are being employed in blends, and new blend types are being tested. Each year, the United States consumes around 15 billion gallons of gasoline combined with ethanol, or about 12% of all fuel sold in the country (Table1).

Welfares of ethanol when used a fuel

- Numerous advantages can be listed in terms of economic and environment on employing ethanol as fuel. Here is a list of these advantages in more detail.
- Lessened dangerous exhaust emissions
- A sustainable source of energy
- Less reliance on foreign oil and gas suppliers
- Biodegradable and has no harmful environmental effects
- Due to the cycle of growth and burning, do not add to the greenhouse effect.
- Low-cost way to produce high-octane fuel

- Several vehicles can run on ethanol without any alterations.
- May lower levels of toxic pollutants from fuel mixes.

Ethanol Sources

Three diverse categories for production of ethanol can be mentioned as follows

- Tubers, corn, and grains contain starch.
- Trees of sugar (sugarcane/sugar beet)
- Cellulosic plants (universal tree and biomasses)

3. Impacts on the Environmental

All plants for production of biofuel's use the carbon cycle to manage the carbon via photosynthesis. Burning of biofuels releases carbon into the atmosphere once again. Hence, the burning of biofuels will not result in an overall increment of CO_2 in atmosphere. There would be a net reduction in CO2 emissions if biofuels were utilized in place of petroleum fuel. According to estimates, each ton of biofuel produced or used prevents the production of greenhouse gases equal to three tones of CO_2. Wasteland plantations of Jatropha and Pongamia have the ability to rehabilitate the ground and reclaim these areas for agricultural use. By litter deposition, nutrient recycling from subterranean layers, and fixing in the instance of legumes, the existence of tree shelter is probable to benefit the health of the soil. In addition to increasing soil fertility, organic matter addition will also enhance the physical qualities of the soil. The shade provided by the plants can be used to intercrop shade-loving vegetables that can generate extra money for the farmers once they have grown and nourished the soil. The tree cover guards against further deterioration by wind and water erosion on the waste and marginal lands.

Benefits of biodiesel

- In different words, utilizing a 100 percent biodiesel in our car implies we are not contributing to the global warming catastrophe. a) The most important environmental benefit of biodiesel is that it's miles carbon impartial. As it makes use of the carbon that already evidently movements among the atmosphere and the biosphere, biodiesel would not upload any new carbon to the ecosystem.
- Biodiesel reduces carbon dioxide (CO_2) emissions by means of 78.45 percent and carbon monoxide (CO) emissions by about 50 percent.
- The amount of aromatic hydrocarbons in biodiesel is lower.
- Considering biodiesel does not include Sulphur, it additionally gets rid of SO_2 emissions.
- It has an extra cetane grade than petrol diesel, because of this much less knocking.
- Spilling can be done without creation of a dangerous region because it is harmless. It is completely biodegradable, in fact.
- Handling biodiesel is secure.

4. Future potential

- As modern yield improvement technologies have so far avoided hilly and island areas, there is a need to create and spread eco-technologies for these areas.
- Agricultural methods must be established on the accessibility of resources, and value addition, amplification, and diversity must all be encouraged.
- Sustainable management strategies and water conservation techniques will need special consideration.
- Create and spread crop combinations depending on ecological and financial factors, such as fruits, vegetables, and biofuel crops having high-value and demand.
- So, it is anticipated that future research on sorghum would focus mostly on modification of genes to boost production efficiency of food crop, provender and feed crop, industrialized and bioenergy crop.
- It would become more important to adapt research to changing industrial needs in order to retain the competitiveness of grain, increase its potential for bioenergy, and maximize the use of byproducts.

Fossil fuels cannot be used indefinitely. On the other hand, because they may go through a continual cycle of growth, burning, and growth, biofuels are sustainable energy sources. Making biofuels at domestic, in small groups, and by means of farming businesses is simple. In flip, this could make biofuels an affordable alternative for fossil fuels and resource in the social and economic improvement of nearby communities. Standard diesel engines can run on biodiesel without the need for engine changes. It's far a biofuel created from non-fossil sources.

5. Increasing awareness and importance of Biofuels

As we utilize more and more devices in our daily lives, the demand for energy worldwide is rising. The demand for energy from fossil fuels has increased due to the emergence of new, high-level energy consumers like China and India. Energy from fossil fuels is turning into much less and less on hand, and their price is growing. The best desire is to search for alternative assets of strength for our everyday desires. One among the best sources of alternate energy to meet future needs of energy is biofuels. Alternative energy is the best choice in terms of environmental pollution. Both economically and environmentally, it is turning into an increasing number of elaborate how we meet our strength wishes and with what fuels. The US administration recently acknowledged the need to lessen its "addiction" to foreign oil and become more energy self-sufficient. By 2010, the European Commission wants biofuels to make up 5.70 percent of the fuels utilized in the continent.

Explanations for promotion biofuels in globally

Because biofuels can be renewed, one can employ them augment hydrocarbon fuels, help with their conservation, cut GHG emissions, and lessen the negative impacts of global warming on the climate. Both ethanol and biodiesel are better fuels from an environmental standpoint. Given the constriction of emissions from automotive vehicles, requirements and court interventions, the use of biofuels becomes persuasive. The necessity of ensuring energy safety and security, particularly for countryside areas. The requirement for job creation, particularly for the countryside poor

residing in extents with a high rate of deprivation of land. Supplying soil with nutrients required by plants, stopping erosion of soil, and so avoiding deterioration of land. Handling the issue of limiting carbon emissions, which is a worldwide concern. Reducing dependence on oil imports. The ability to use biofuels in current engines without significant change. The production of biofuels using currently underutilized molasses and land resources, creating jobs for the poor in the process. Using biofuels doesn't necessitate a lot of extensive or drawn-out research or studies. Programs on production of biofuel in major cities are practical, preferred by the environment, and causes least harm to health of living beings.

6.Conclusion

For a variety of reasons, the usage of biofuels as a substitute fuel for vehicles is seen to be rising significantly. The major three objectives of using alternate source of energy are to cause reduction in emissions of greenhouse gases, reduced the present transactions for importing energy, and to enhance the livelihood of farmers. The important thing is to utilize the biomass sources, like the stable wastes from municipality, and pavement of roads for energy vegetation and biofuels, particularly ethanol, as alternatives to fossil fuels are recent research discoveries and the promise of others. Agricultural studies have shown that biofuel crops are efficient feedstock plants that could replace fossil fuels. Additionally, accessible cellulosic material like wood and crop residue may now be used to produce ethanol thanks to an innovative new biotechnology that involves saccharification and fermentation. Notwithstanding the great range and significance of biofuel crops in terms of feed, food, and fiber, they are aimed to play a significant role in helping to meet the nations' constantly increasing need.

References

1. Abhishek Maharishi (2005) Biodiesel from Jatropha. Agriculture and Industry Survey.15 (1): 65-68.

2. Buran (2003) Environmental benefits of implementing Alternate energy technologies in developing countries. Applied Energy 76: 89- 100.

3. De gang Li, Huang Zhen, Lŭ Xingcai, Zhang Wu-gao, Yang Jian-guang (2005) Physio chemical properties of ethanol-diesel blend fuel and its effect on performance and emission of diesel engines. Renewable energy 30(6): 967-976.

4. K. Jeswani, A. Chilvers, and A. Azapagic, “Environmental sustainability of biofuels: a review,” Proc. R. Soc. A, vol. 476, no. 2243, Nov. 2020, doi: 10.1098/RSPA.2020.0351.

5. S. Achinas, G. Jan Willem Euverink, and V. Achinas, A relook on the biofuels: how can industrial processes underpin the drive for sustainable development? Elsevier, 2021. doi: 10.1016/B978-0-12-820297-5.00006-2.

6. Fernando S, M Hanna (2005) Phase behavior of the ethanol-biodiesel- diesel micro-emulsion system. Transaction of the ASAE 48 (3): 903- 908.

7. Hamelinck CN, Faaji APC (2006) Production of advanced biofuels. Intl Sugar j 108 (1287): 168-175. Indian Renewable Energy Development Agency limited.

8. Lal R (2005) World crop residues production and implications of its use as a biofuel.

Environment International 31(4): 575-584.

9. Parikh J (2005) Growing our own oils. Biofuels India Vol iii (3): 7.

10. Shukla SK (2005) Experiences of Chattisgarh biofuels development authority. Biofuels India Vpl (4): 12-13.

11. R. Cabrera-Jiménez, J. M. Mateo-Sanz, J. Gavaldà, L. Jiménez, and C. Pozo, "Comparing biofuels through the lens of sustainability: A data envelopment analysis approach," Appl. Energy, vol. 307, p. 118201, Feb. 2022, doi: 10.1016/J.APENERGY.2021.118201.

12. Unnikrishnan M, Santha V Pillai, (Eds) and MN Sheela (2006) Biodiversity of root and tuber crops. Kisan World, 33(11): 11-13.

13. H. Pistonesi, G. Nadal, V. Bravo, and D. Bouille, "The contribution of biofuels to the sustainability of development in Latin America and the Caribbean: elements for formulating public policy".

14. (2002) Using the indigenous Knowledge of Jatropha, IK Notes, No.47.

15. Biofuels: Plants and Trees as Source of Bioenergy." https://www.researchgate.net/publication/270051301_Biofuels_Plants_and_Trees_as_Source_of_Bioenergy (accessed Apr. 05, 2023).

16. N. K. Patel and S. N. Shah, "Biodiesel from Plant Oils," Food, Energy, Water Chem. Connect., pp. 277–307, Jan. 2015, doi: 10.1016/B978-0-12-800211-7.00011-9.

17. E. E. Hood, "Plant-based biofuels," F1000Research, vol. 5, 2016, doi: 10.12688/F1000RESEARCH.7418.1.

18. Biofuels from biomass: A sustainable alternative to energy and environment." https://www.researchgate.net/publication/255792266_Biofuels_from_biomass_A_sustainable_alternative_to_energy_and_environment (accessed Apr. 05, 2023).

19. M. Meena, S. Shubham, K. Paritosh, N. Pareek, and V. Vivekanand, "Production of biofuels from biomass: Predicting the energy employing artificial intelligence modelling," Bioresour. Technol., vol. 340, p. 125642, Nov. 2021, doi: 10.1016/J.BIORTECH.2021.125642.

20. A. I. Osman, N. Mehta, A. M. Elgarahy, A. Al-Hinai, A. H. Al-Muhtaseb, and D. W. Rooney, "Conversion of biomass to biofuels and life cycle assessment: a review," Environ. Chem. Lett. 2021 196, vol. 19, no. 6, pp. 4075–4118, Jul. 2021, doi: 10.1007/S10311-021-01273-0.

21. V. Micic and M. Jotanovic, "Bioethanol as fuel for internal combustion engines," Zast. Mater., vol. 56, no. 4, pp. 403–408, 2015, doi: 10.5937/ZASMAT1504403M.

22. V. Micic and M. Jotanovic, "Bioethanol as fuel for internal combustion engines," Zast. Mater., vol. 56, no. 4, pp. 403–408, 2015, doi: 10.5937/ZASMAT1504403M.