STUDIES ON THE ASSESSMENT AND PRODUCTION OF BIOFUELS IN INDIA: A SYSTEMATIC REVIEW

N.B. Hirulkar, Ashwini M. Bhurre*
Department of Microbiology, Nabira Mahavidyalaya, Katol, Dist. Nagpur MS 441302
*Corresponding Author: ashwinibhurre@gmail.com

ABSTRACT:
This report examines India's initiatives to lessen its dependency on fossil fuels and diversify its energy sources. It assesses the production and use of bio fuels from a variety of feed stock, including waste biomass, sugarcane, and jatropha. Along with social and environmental effects, the research looks at scientific developments, legal systems, and economic ramifications.
Keywords: biofuels, production, assessment, India, environmental impacts.

INTRODUCTION:

The majority of energy used by humans comes from fuels; renewable energy sources, such as solar panels and windmills, provide only 3% of the total; the remaining 97% comes from fossil fuels, nuclear power, and biofuels. (1) Worldwide efforts are being made to decrease the use of fossil fuels in order to mitigate the effects of global warming. In an effort to replace conventional fuels, thought tanks are researching alternative fuels; however, this is a difficult undertaking. (2)The Agricultural commodity prices have roughly doubled from their starting levels despite the collapse of the commodities bubble during the last four years; however, commodity markets have seen considerable price volatility. (3)

The spike in energy demand is driving the 9% growth rate in the Indian economy. By 2030, India wants to be the third-largest oil importer globally, with daily imports predicted to reach over 6 million barrels. Biofuels are being seen as a dependable replacement for petroleum fuels, with the ability to lower greenhouse gas emissions. They are mostly produced by contemporary carbon fixation techniques. (4) By 2017, the Indian government hopes to have launched multiple initiatives to boost the production and usage of biofuels, with the goal of blending up to 20% of them with gasoline and diesel in the transportation sector. The 2009 "National Policy on Biofuels" seeks to lessen reliance on fossil fuels and promote national energy conservation. (5)

Generations of Biofuels:

First-generation Biofuels: First-generation biofuels are generated from vegetable oil, sugar, or starch and are separated from byproducts and main products by fermentation, distillation, and transesterification. They contain ethanol for lower emissions.(6)

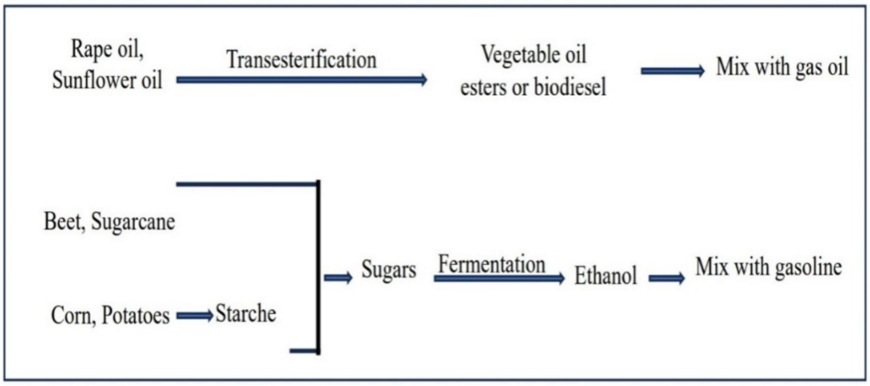


Fig. 1: First-generation biofuels

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-11, ISSUE-9, 2024
DOI: 10.21276/ijcesr.2024.11.9.44

Second-generation Biofuels: In spite of the possibility of employing underutilized food crop regions, secondary biofuels confront challenging production procedures and competition from other land uses. However, they provide more energy per acre and alleviate some of the problems associated with primary biofuels. (6)

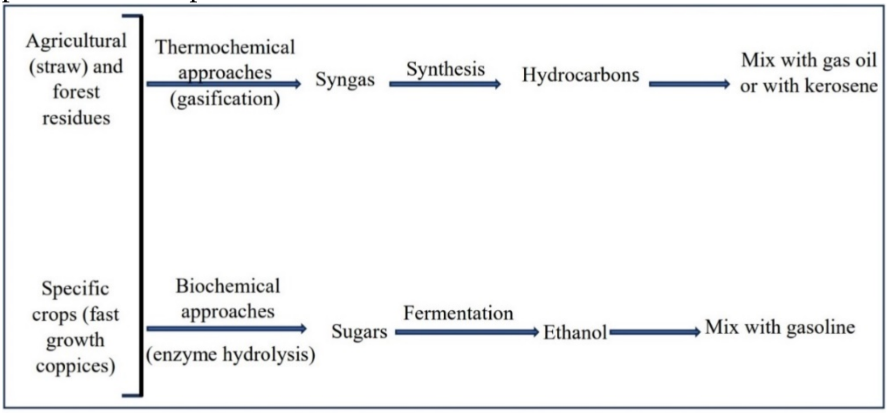


Fig. 2: Second-generation biofuels

Third-generation biofuels: Saltwater, sewage, and wastewater can all be used to grow algae, which can be produced in unfavorable places and uses less water overall. Algae is a cheap, sustainable, and energy-efficient source of biofuel. (6)

Evaluation of Biofuels: In order to achieve India's 2030 target of 20% bioethanol and 5% biodiesel blends, a sizable domestic advanced biofuels industry that evaluates waste and byproduct sustainability is needed. This is stated in the country's 2018 National Policy on Biofuels.By projecting advanced biofuel output based on availability and development assumptions for architecture, the study assesses India's capacity to reach its 2030 biofuel ambitions.(7)

MATERIALS AND METHODS: Using databases such as Research Gate, Science Direct, Web of Science, and Scopus, the literature review concentrated on sustainability and economics beyond production and evaluation models in order to locate papers on biofuels and their manufacturing in India.

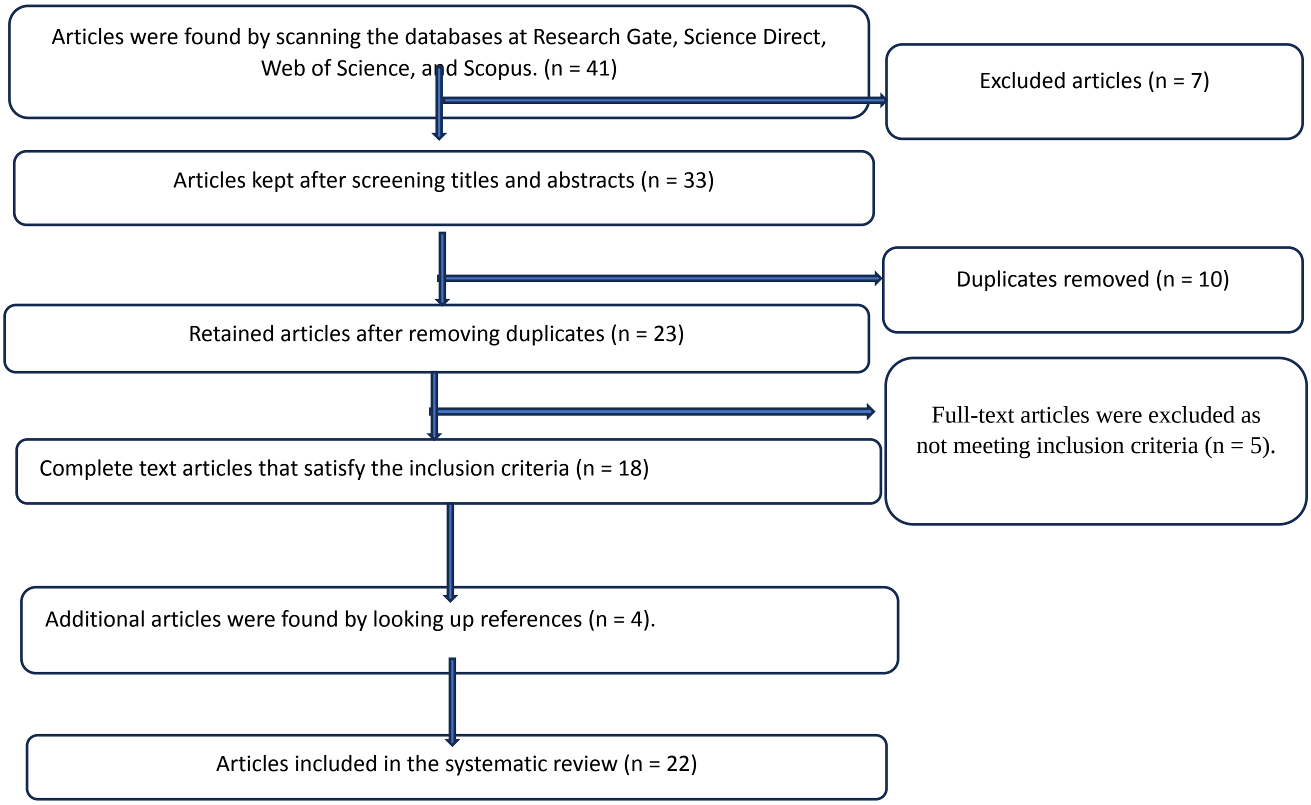


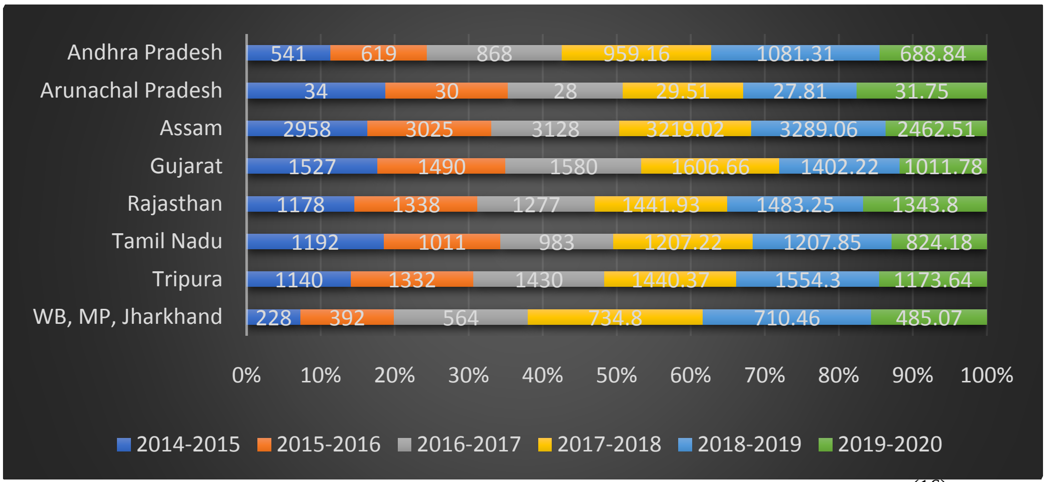
Fig. 4: PRISMA flow chart

Table 2: Production of biofuels from different sources:

Sr. No.	Name of the Source	Production	Reference
		Sugarcane and starchy source-based biofuels	
1)	**Using molasses**	A number of processes are involved in the refining process to turn molasses into ethanol.	[9]
2)	**Cellulosic material**	Plant biomass contains lignocellulosic acid, which can be obtained from paper waste and grasses. Starch and non-sugar components make up 60–80% of bioethanol, which is mainly created through pretreatment.	[9]
3)	**Biomass**	The Acetone Butanol Ethanol (ABE) method turns sugar, starch, or cellulosic feedstocks into biobutanol, a byproduct of microbial fermentation. However, because of its toxicity, commercial production of biobutanol is hampered.	[10]
		Biodiesel Production	
1)	**Vegetable oil**	When used properly, the monoalkali ester biodiesel—which is made from vegetable or animal fat—produces very little emissions and is safe for the environment.	[11] [12]
		Biofuel will overtake diesel as the leading fuel on the world market by 2015, making up 27% of fuel worldwide and cutting CO_2 emissions by 2.1 gigatons.	
		The global energy problem is linked to the depletion of fossil fuels, which harms the environment and increases reliance on imported energy, which is expected to reach 90% by 2030.	
		Microbe-based biofuels	
1)	**Anaerobic microbes**		[13]
	Clostridia	Fossil fuel depletion is linked to the global energy crisis, which harms the environment and increases the need for imported energy, which is expected to increase to 90% by 2030.	
	Methanogenic Bacteria	Methanogen *Methanobacteriumsoehngenii* can digest formate and grow on acetate, using hydrogenase to absorb CO and CH_4.	
	Archaea	In microbiology, hydrogen is oxidized by iron-sulfur proteins and nickel-containing enzymes. *Pyrococcusfuriosus*'s HD produces H_2 from peptides and carbohydrates, whereas ferrodoxin-linked oxido-reductases initiate HD production.	
2)	**Facultative Anaerobes**		[13]
	Escherichia coli	Benzyl viologen is affected by the enzyme formatehydrogenylase (FHL), which hydrolyzesformate into CO_2 and H_2. This process is interrupted by aeration.	
	Enterobacter	This strain of *Enterobacter aerogenes* can produce H_2 at 38–40 ºC, with a maximum productivity of 0.20-0.21 $1H_2$/h/l. It also affects biomass output and pH.	
3)	**Aerobes**		[13]
	Alcaligenes	Aerobic H_2 bacteria use H_2 and CO_2 to create soluble NAD-reducing HD, which is then ejected as H_2. The bacteria grow on gluconate or fructose.	
	Bacillus	Cattle manure contains Bacillus licheniformis, which ferments glucose to produce 13 H_2/mol per day on average, with a conversion ratio of 1.5 mol H_2/mol glucose.	
	Cyanobacteria	The oxygen-loving phototrophic microorganisms known as cyanobacteria produce hydrogen gas through the utilization of photosystems I and II and nitrogenase systems; nonheterocystous species, on the other hand, require anoxia and a nitrogen deficit.	
4)	**Algae**	80% of the electrons in *Chlamydomonasreinhardtii*'s Photosystem II are produced by ferredoxins, which are also vital for photosynthesis in cyanobacteria and green algae.	[14]

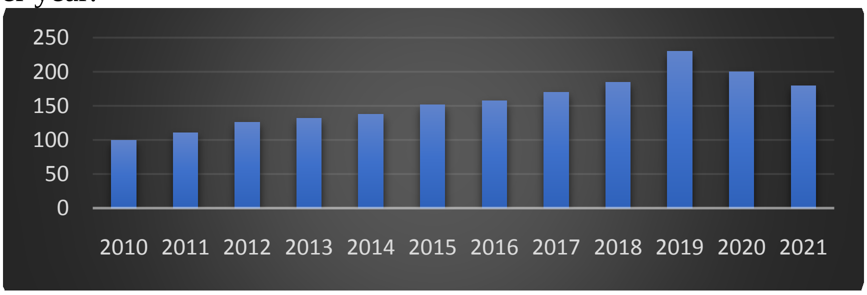
Status at the National Level: Global biofuel demand is expected to increase by 23% by 2028, mostly due to sustainable diesel and biojet, with ethanol and biodiesel continuing to be used as alternative fuels.

India is now the third-largest producer and user of fuel in the world, having tripled its ethanol output in the last five years. India's National Policy on Biofuels was introduced in 2018 with the goal of keeping costs under control and securing sustainable feedstocks for future expansion.[15]



Graph 1: Trends in State-Level Natural Gas Production[16]

By 2030, India wants to produce 5% more biojet fuel and biodiesel, which will require 4.5 billion gallons per year.[15]

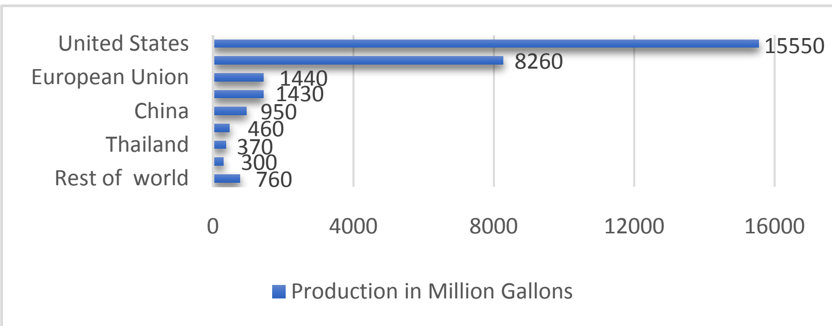


Graph 2: Biodiesel Production Volume in India between 2010 and 2021[17]

Global Position:

Eighty percent of development originates from the US, Canada, Brazil, Indonesia, and India, who are at the forefront of the world's biofuel usage. The demand for gasoline and diesel is rising in Brazil, Indonesia, and India despite a decline in the US and Canada due to growing fuel consumption.

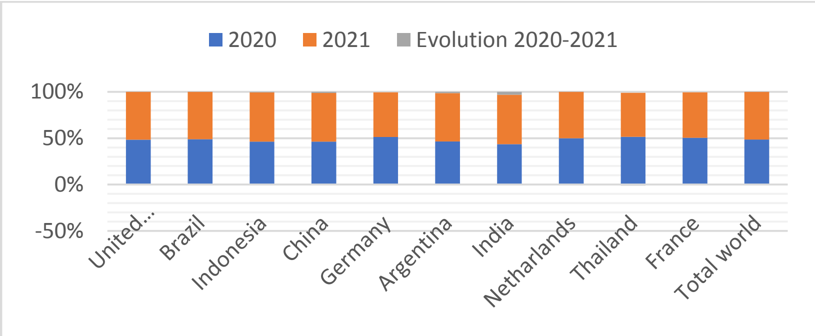
The demand for biofuels is expected to rise by 25% to 240,000 MLPY under the accelerated scenario, mostly as a result of stronger regulations from the US, China, Europe, and India as well as successful ethanol blending programs in those countries.[18]



ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-11, ISSUE-9, 2024
DOI: 10.21276/ijcesr.2024.11.9.44

Graph 3: Production of Fuel Ethanol by Leading Countries Worldwide (million gallons)[1

It is anticipated that in 2022, the world's need for biofuels will increase by 6% to 9100 million liters annually. The main contributor is diesel made from renewable resources; growth is also being experienced in Brazil, Indonesia, and India. [18]



Graph 4: Production of Biofuels Worldwide (measured in thousand barrels of oil equivalent per day, or boe/d)[20]

Discussion:A study on the development and evaluation of biofuels in India examined 44 publications using a variety of search engines, including Research Gate, Science Direct, Web of Science, and Scopus.

Mizik T. et al. (2020)[21]Future studies should broaden their focus and investigate neglected subjects like sustainability and renewable energy sources, as well as the environmental, social, and policy ramifications of the biodiesel sector.

Aruwajoye GS et al. (2020)[22]Fossil fuel substitutes have difficulties such as the transportation of feedstock, low yields of biofuel, and high processing costs. The synthesis of bioethanol and biohydrogen from agricultural wastes can boost output and profitability.

Rajalingam A. et al. (2016)[11] Transesterification is an economical and effective way to make biodiesel. It produces glycerol for a variety of uses and requires less equipment. The fuel quality is greater.

Kothari A. et al. (2013)[2]Production, byproducts, and economic considerations are taken into account before beginning the process of replacing crude oil with algae biofuels as an alternative energy source.

Reijnders L. et al. (2009) [1]Renewable biofuels, such as solar and wind power, have a declining cost curve, but unconventional fuels, such as bituminous oil, coal liquids, and methane, have large emissions, waste, and water inputs.

Shamsudheen SU et al. (2008)[10]In order to increase engine efficiency and cut emissions, the study investigates the possibility of using biobutanol as an alternative to gasoline. However, there are drawbacks, including pollution and engine damage, as well as reduced production and higher costs.

FUTURE PROSPECTS:

Policy and Regulatory Assistance: Research and development in the biofuel business is the goal of government programs in India, including the National Policy on Biofuels and the Ethanol Blended Petrol Programme.

Developments in Technology: Research into enhanced feedstock, bioconversion processes, and integrated biorefinery concepts is required for sustainability and efficiency due to advancements in biofuel production technology, especially for second and third generation biofuels.

Sustainability and Advantages for the Environment: Environmental impact assessments of biofuels' lifetimes are essential for sustainable development since they are a more environmentally friendly fuel than fossil fuels, as they lower greenhouse gas emissions and enhance air quality.

Rural Development and Economic Growth: By opening up new markets for agriculture, generating employment, and encouraging collaboration between

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-11, ISSUE-9, 2024
DOI: 10.21276/ijcesr.2024.11.9.44

companies, researchers, and farmers, the biofuel industry can improve rural development.

Global Cooperation: Research and technology transfer collaboration among nations may stimulate the growth of the biofuel industry and produce useful information and resources from developed countries.

Conclusion: The biofuel industry in India has the potential to lower emissions, promote long-term economic growth, and provide energy security. For development to be effective, obstacles like feedstock supply networks and legal frameworks must be overcome.

Bibliography:-

1. Reijnders L. Fuels for the future. Journal of Integrative Environmental Sciences. 2009 Dec 1;6(4):279-94.
2. Kothari A, Gujral SS. Introduction to bio-fuel and its production from Algae: An overview. International Journal of Pharma and Biosciences. 2013;3(1):269-80.
3. Timilsina GR, Beghin JC, Van der Mensbrugghe D, Mevel S. The impacts of biofuels targets on land-use change and food supply: a global CGE assessment. Agricultural Economics. 2012 May;43(3):315-32.
4. Ravindranath NH, Lakshmi CS, Manuvie R, Balachandra P. Biofuel production and implications for land use, food production and environment in India. Energy policy. 2011 Oct 1;39(10):5737-45.
5. Blanchard R, Bhattacharya SC, Chowdhury M, Chowdhury B, Biswas K, Choudhury BK. A review of biofuels in India: challenges and opportunities.
6. Website of Generation of Biofuels: Bioenergy Education Initiative (https://agsci.oregonstate.edu).
7. Pavlenko N, Searle S. The potential for advanced biofuels in India: Assessing the availability of feedstocks and deployable technologies. IntCouncclean Transp. 2019 Dec.
8. Evolution of Biofuels in India. Indian Economy.https://www.drishtiias.com/printpdf/biofuels-1
9. Ibeto CN, Ofoefule AU, Agbo KE. A global overview of biomass potentials for bioethanol production: a renewable alternative fuel. Trends in Applied Sciences Research. 2011 May 1;6(5):410.
10. Shamsudheen SU, Mn SH, Cp NI, FasilVp M, Paul JO. Performance analysis and feasibility study of bio-butanol as a potential substitute to gasoline in spark ignition engine. Int Res J Eng Technol, June. www. irjet. net. 2008.
11. Rajalingam A, Jani SP, Kumar AS, Khan MA. Production methods of biodiesel. Journal of Chemical and Pharmaceutical Research. 2016 May 4;8(3):170-3.
12. Khan SA, Hussain MZ, Prasad S, Banerjee UC. Prospects of biodiesel production from microalgae in India. Renewable and sustainable energy reviews. 2009 Dec 1;13(9):2361-72.
13. Nandi R, Sengupta S. Microbial production of hydrogen: an overview. Critical reviews in microbiology. 1998 Jan 1;24(1):61-84.
14. Website of Algae Biofuel Market Size and Share Analysis Report: Grand View Research, Inc.
15. IEA (2024), India could triple its biofuel use and accelerate global deployment, IEA, Parishttps://www.iea.org/commentaries/india-could-triple-its-biofuel-use-andaccelerate-global-deployment, Licence: CC BY 4.0.
16. https://mopng.gov.in/en/exp-and prod/production
17. https://www.statista.com/statistics/1051902/india-biodiesel-production-volume/
18. IEA (2022), Renewables 2022, IEA, Paris https://www.iea.org/reports/renewables-2022, Licence: CC BY 4.0.
19. https://www.statista.com/statistics/281606/ethanol-production-in-selected-countries/
20. https://www.statista.com/statistics/274168/biofuel-production-in-leading-countries-in-oilequivalent/#:~:text=Global%20biofuel%20production%20has%20gradually,fuel%20sources%20or%20as%20additives.
21. Mizik T, Gyarmati G. Economic and sustainability of biodiesel production—a systematic literature review. Clean Technologies. 2021 Jan 8;3(1):19-36.
22. Aruwajoye GS, Kassim A, Saha AK, Gueguim Kana EB. Prospects for the improvement of bioethanol and biohydrogen production from mixed starch-based agricultural wastes. Energies. 2020 Dec 15;13(24):6609.

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-11, ISSUE-9, 2024
DOI: 10.21276/ijcesr.2024.11.9.44