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Prospects of Factor Affecting Biodiesel Selection Strategies Based on Various Aspects: An Indian Perspective

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ABSTRACT

The need for alternative and viable energy sources for the automotive industry is increasing due to the fast depletion of fossil fuel reserves. In the present scenario fluctuating petroleum prices. Inconsistent supply, global politics, conflicts of oil-producing countries sky-rocketing energy demands, lacking oil reserves make an energy-intensive country like India, vulnerable to energy security. For a few years, researchers across the world found Biodiesel as a favourable potential energy source to fulfil its energy needs due to its availability, renewable nature, low toxicity and lesser polluting nature. There are various sources of biofuel identified by the scientists and researchers so far, which include edible oil, non-edible oil, animal fats, microbial feedstocks, waste cooking oil, etc. making biodiesel viable for use and economical for production is the very next challenge for researchers. The present work, emphasises on various selection criteria e.g. physicochemical properties, structural composition, environmental aspects, economic aspects etc. to choose better alternative out of the available biofuel resources. This paper will extensively contribute to identifying the most appropriate and cost-effective feedstocks for biodiesel selection for greater use.

Keywords: Animal fats; Automotive industry; Biofuel; Fossil fuel

INTRODUCTION

A regular energy supply for a sustainable future is the most important element for the economy of any country particularly for developing and poor countries. As per the energy consumption usage analysis by the international energy agency, by the middle of this century, there will be about a 53% expansion in global use of energy . In the current scenario, gasoline or petroleum products remained the main energy sources used worldwide, which increased by almost 3% in 2018, compared with 2.4% in 2017, 1.2% in 2016, 0.95% in 2015 (Gautam et al. 2019). The vehicle, modern areas, and age of force are the main buyers of essential energy, and the area of the vehicle is growing faster than all others. The shortage of petroleum-based fuel may be considered as a sustainable and attractive hot spot for elective fuel for the future (Azad et al. 2014). However, biodiesel powers are being taken into account worldwide as a mixture part or an immediate substitute of petroleum in diesel engines (Demirbas and management 2009). As a result, biofuel is thought out to be potentially elective assets for highly engine diesel from non-saleable feed-stock oil. Moreover, biodiesels have an extraordinary perspective as the fuel of the future.

The exits from energy burn areas cause extreme natural pollution as a side-effect exhausting substance. GHG emmissions causes an environmental change through heat capture and adds to respiratory medical problem. The research suggests that GHG emissions from petroleum derivatives will increase by 39% in 2030 if no shields have been taken (Mofijur et al. 2012). Continuing, confidence in the oil derivative will finally make an extreme emergency in human well-being and the seriousness of the atmosphere, at that movement world, can't keep looking. In addition, the shortage of regular petroleum derivatives, the expansion of ignition outlets generated poisons, ozone-depleting substances have caused climate pollution and increased temperature throughout the earth (Singh et al. 2012). Analysts are working eagerly, particularly in the vehicle area, to distinguish different options. The motive is to promote the utilization of renewable energy and to limit the antagonistic impacts of pollution from exhaust fumes. Analysts have expressed that the biofuel utilized in an IC engine will decrease the process with interest in the non-renewable energy source and alleviate the negative effects on global well-being (Anwar, Rasul, and Ashwath 2018).

The decision of the inexhaustible points of interest for biodiesel production is anything but a typical model for all over the world. Essential factors, for example, the cost and accessibility of the neighborhood can assume an important part in determining the raw material (Singh et al. 2019). Analysts are of the view that most biofuels have comparable physicochemical properties about their non-hazardous, non-harmful, recyclable, and no fuel attributes (Ong et al. 2019). Different aspects of evaluation to be used in biodiesel feedstock selection process: (i) Technical aspects include biomass content, ease of harvesting, energy efficiency, physicochemical properties, energy content, fatty acid compostion, safety and availability. (ii) Economic aspects include investment, storage cost, cultivation cost, transportation cost, labour cost, payback period, harvesting cost. (iii) Environmental aspects include pollution, water irrigation, biodiversity, land usage, cultivation method, chemical usage. (iv) Social aspects include social benefits, social acceptance, social development. Lin et al. (Lin et al. 2011) called attention to the three main thrusts and difficulties to create alternative fuel industry, for example, (i) as sustainable power, biofuel can add to the decrease of GHG outflows essentially when supplanting fossil oil; (ii) it will assume a significant job in reinforcing the country's energy security as the world is facing an energy scarcity situation [iii] the expanded interest of agriculture product for biodiesel production. Be that as it may, with the worldwide expansion in the size of biodiesel creation, biodiesel has become a precise danger for its financial, biological, and social effects. it is accounted for that chances, obstacles and even dangers have been raised (Janaun, Ellis, and Reviews 2010). The significant parts of biofuel which uncovered the possibility as the cutting edge green fuel, e.g. [i] ecological effect and cost of transformation measure; [ii] difficulties and key drivers of biofuel industry improvement; [iii] endeavors en route for earth benevolent and cleaner discharges; [iv] broadening of items of glycerol from biodiesel; and [v] strategy and motivations from the government (Atabani et al. 2013). We as a researcher have various bits of examination that have been distributed as of late zeroing in on the particular issues identified with creation cycle, feedstock, and social, economy and strategy. In the current work, accentuation is for the possibilities of the second-era biofuel as a reasonable fuel. This paper will focus to distinguish the fitting and savvy feedstocks, and the most effective innovation for delivering modern-era biodiesel which will serve as a better alternative to the current reliance on petroleum derivatives around the world.

FEEDSTOCKS FOR BIODIESEL PRODUCTION

Researchers from across the world are engaged in finding out the best possible alternative feedstocks for biofuel production. Though, choosing the better quality feedstock at an economically viable cost is critical for ensuring low biodiesel production costs. Biofuel feedstocks should, to the greatest extent possible, meet two requirements for biodiesel production: lower production price and enhanced production scale. It is a fact that a country's regional environment, geographic location, soil condition as well as agricultural practices usually decides the availability of biofuel feedstock.

When comparing various feedstocks, certain criteria must be taken into account. A complete life-cycle review should be performed on each feedstock. These include (1) land availability, (2) farming methods, (3) economic value of feedstocks, (4) Soil degradation & its infertility (5) loss of biodiversity (6) costs incurred for logistics (7) pesticides injections (8) greenhouse gas emissions (9) energy equivalence. Algae has been listed as non-edible vegetable oils by the majority of the researchers. On the other hand, only a few scholars, such as Moser (Moser 2011) have considered algae in a different category because of its high oil content and being non-edible oil. Classification of feedstocks on different basis are as follows:

(I) Generation wise examples of biodiesel feedstock: Ist generation biofuel feedstocks include Soybeans, Rice bran oil, Sorghum, Wheat, Coconut, Palm, Sunflower, Barley, Corn, Peanut, Rapeseed, etc. IInd generation non-edible oils are Jatropha, Cottonseed, Neem, Mahua, Salmon oil, Moringa, Rubber seed, Nag champa, Tobacco seed, Jojoba etc. IInd generation biodiesel feedstocks include Fish oil, Pork lard, Chicken fat, Beef tallow, Poultry fat, etc. IIIrd generation biodiesel feedstocks are Bacteria, Microalgae, Fungi etc.

(II) On the basis of origin: Edible oil include Sunflower, Palm, Safflower, Coconut, Barley, Peanut, Wheat, Corn, Sorghum, Canola, Rice bran, Soybeans, Sesame, Palm kernel, Rapeseed, Hazelnut, Walnut. Non edible oil include Karanja or honge, Jatropha, Cottonseed, Camelina, Abutilon muticum, Jojoba, Cynara cardunculus, Cumaru, Neem, Tobacco Seed, Passion seed, Tall, Moringa, Rubber seed tree, Nagchampa, Coffee ground, Croton megalocarpus, Mahua, Kusum, Castor, Linseed, Eucalyptus oil etc. Animal fats include Poultry fat, Beef tallow, Fish oil, Pork lard etc. Microbial feedstocks include Fungi, Microalgae etc. Waste oil include Leather tanning waste, waste cooking oil, Date pit oil, etc.

Algae oil (Macro & micro) is a non-edible oil resource that is a much better source than many for biodiesel production. Microalgae may be a viable and cost-effective source of biofuel (Chisti 2007). Microalgae have a higher photosynthetic ability, biomass production, and growth rate than energy crops (Canakci, Sanli, and Biotechnology 2008). Furthermore, since its production does not necessitate a large amount of ground. Furthermore, microalgae cultivation can be grown on saltwater or sewage, it does not need fertile land. Microalgae, on the other hand, are an underutilized resource with over 25000 species, only 15 of which are used. Though microalgae can replace diesel for engine use it was the same disadvantages as diesel fuel which include, lower volatility, higher viscosity and unsaturated hydrocarbon chain operation (Friday and Okano 2006).

WCO can be obtained from various places mostly from restaurants and households is a very good source of alternative feedstock. The use of WCO lowers the cost of producing biodiesel dramatically when compared with the cost of producing crude oil. Nowadays, it has been discovered that restaurants, food manufacturing plants, fast-food restaurants, and households produce a considerable amount of waste lipids. According to reports, improper disposal of WCO causes severe environmental issues in many countries. WCO as a diesel fuel could be used and managed properly to solve this issue (Agrawal et al. 2020). As the WCO is reused after frying its chemical & physical properties change from those of fresh oils . As the standard of living is increasing.

Animal fats e.g. Tallow (Gautam and Kumar 2020) is an important sources of feedstock that is used to make biodiesel. The animal fat methyl ester has been found to have some advantages, including, a high cetane number, non-corrosion, safe and renewable properties. It has some drawbacks e.g. higher flash point, viscosity, pour point but advantages of being low in water content and more importantly lesser free fatty acids (FFAs) (Giakoumis 2013). The biodiesel feedstock with higher oil content and better conversion rate is the most effective one with higher engine efficiency, better emission characteristics and good combustion behavior. East Asia's tropical climate favors the growth of the Palm (Elaeis Guineensis), which accounts for nearly 80% of the global production of Palm (Issariyakul, Dalai, and Reviews 2014). This variety can produce 10-35 tonnes of fruit per hectare (Habibullah et al. 2014).

Moringa (Moringa oleifera) is a small tree that grows quickly and is drought resistant. It originated in South and Southeast Asia's tropical and subtropical climates. India is the world's leading producer of Moringa (Sekhar et al. 2018). Moringa leaves can be eaten as a vegetable, and the oil is primarily used in traditional herbal medicines. Though Moringa seeds have a high percentage of oil in it but are of restricted use as it is becoming more common as an edible oil.

Jatropha is a tropical & subtropical climate plant. It can be grown on barren land and is a drought-tolerant tree with an average height of 5-7 m tall. It produces 1 to 8 tonnes of seeds per year per hectare of land. Around 77.4% of the seed's fatty acids are unsaturated, while 22.6% are saturated. Jatropha (JBD) oil has a very high content of linoleic acid and oleic acid and is very common among the non-edible oil category.

Mustard plants thrive in temperate climates. It has a diameter of 1-2 mm and can range in color from blackish to yellow. It is widely used as seeds and oils for food processing because of its distinct flavor. Cold processing is the most popular method of extracting mustard oil. Mustard seeds have 30% oil content and a yield of 1247 L/ha/year. Mustard oil is very unstable because of its very low saturated fatty acid content.

Coconut plants thrive well in a tropical climate and it has an average height of 30 meters. The coconut plant produces 75 fruits a year after planting for 6-10 years. Coconut oil can be processed in two ways: dry and wet. The dry process extracts coconut oil by drying and pressing the kernels, while the wet process extracts oil by using coconut milk. A coconut kernel contains about 63–65 percent oil, which can be extracted at a rate of 2689 L/ha/year. The coconut has Myristic acid (48.83%) and Lauric acid (48.83%) in it

Tallow is a triglyceride-rich rendered source of animal fat. It stays solid at room temperature and can be kept for a long time in an airtight container to avoid oxidation. It has a saturated fatty acid content of 64.42 percent and an unsaturated fatty acid content of 32.28 percent. Tallow has high saturated fatty acid content and so is an excellent primary biodiesel feedstock.

Corn is used as a staple food all over the world and could be used to extract oil. It is grown across the world in enormous quantity like in 2018, the United States produced 371 million tonnes of corn, followed by China, Brazil, Argentina, India, and Indonesia of quantity 259.2 million tonnes, 97.7 million tonnes, 49.5 million tonnes, 28.7 million tonnes, 28 million tonnes respectively . Corn seeds have 20% oil content in them, which is usually extracted by pressing expeller and then using a solvent method for increased production. It contains a lot of oleic acids (29.2%), as well as linoleic acid (54.5 percent).

Rice (Oryza sativa) is the world's most common staple food. India, Vietnam, Bangladesh, China, Myanmar, Thailand, and Indonesia are some of the major rice-producing countries. Ricebran is the outer layer of the rice grain that is separated when brown rice is polished into white rice. It's high in energy, protein, vitamins, minerals, and fiber. The most effective and common method of extracting oil from rice-bran is solvent extraction with n-hexane.

Rapeseed (Brassica napus) is a mustard family (Brassicaceae) plant that can reach a height of 60 cm. It thrives in well-drained soils in cold weather. This is primarily grown for its seeds. It is becoming increasingly common in almost all continents. Natural rapeseed is an inedible commodity due to the erucic acid content (approximately 50%). Rape has been discovered in a variety of animals. Canola oil, on the other hand, can be made from a variety of rapeseed plants. Rapeseed oil content ranges between 38 and 46 percent.

Among all the biodiesel feedstocks available worldwide, the oil from the beauty leaf tree (Calophylluminophyllum) has the highest oil yields(65 percent). It is mainly grown in the Asia Pacific region (Friday and Okano 2006). Fruits are usually spherical and are clustered together. The oil yield from beauty leaf trees is 2000-4000 kg per hectare per year (Atabani et al. 2013)(27,28). It contains a lot of oleic acids (38.2 percent) and linoleic acid (27.6 percent). Beauty leaf oil has 33.4 percent saturated fatty acids which makes it an excellent biodiesel feedstock.

BIODIESEL FEEDSTOCKS SELECTION CRITERIA

Biodiesel feedstock oil yield and biodiesel cost

The selection criteria for biodiesel feedstocks include determination of oil yield, oil content, biodiesel conversion yields well as conversion cost. Oil content is basically for the oil extracted from seeds, oil yield is the oil output per ha/year while conversion cost is the cost per liter. Table 3 reveals that the highest oil content is found in coconut oil and beauty leaf tree (BLT), with 63-65 percent and 65-75 percent, respectively. The beauty leaf tree with a yield of 4680 L/ha/year is the second-highest oil producer. Oil yields of Pongamia and Jatropha are 1892-2689 L/ha/year. The oil yield of Jatropha is 50-60 % and around 1892 L/ha/year of oil can be extracted (Silitonga et al. 2011). A higher conversion rate usually 95% for feedstocks to biodiesel is considered excellent. Biodiesel conversion yields for Rice bran, Rapeseed oil, Peanut, Pongamia, Mustard, Palm, Beauty leaf ranges from 83.34 percent to 94.3 percent. The yields of the other feedstocks tested were over 95%. Biodiesel production costs are affected by (i) feedstock cost which includes investment, harvesting, cultivation, and payback period (ii) labor cost, (iii) storage cost, and (iv) transportation cost. All of these costs are calculated on a zonal basis, meaning that labor costs do not fluctuate significantly, affecting the overall cost of biodiesel output. The most expensive biodiesel is Peanut oil biodiesel, which costs $1.08 per liter, while other biodiesels cost $0.24 to $0.99 per liter. The cheapest biodiesel production costs were found to be Pongamia, Beauty Leaf, and Jatropha, at $0.24, $0.26, and $0.27, respectively.

On the basis of fatty acid composition

After obtaining biodiesel from vegetable oil, the chemical composition of biodiesel has to be determined. Usually, biodiesels are mono-alkyl fatty acid ethyl esters or mono-alkyl fatty acid methyl esters. The fatty acid content of biodiesel is determined by Gas chromatography. Because of their various sources and biodiesel conversion methods, the percentage of fatty acids in them varies. Different oil contains different fatty acids in it e.g. Mustard oil contains about 53.7 percent Erucic acid (22:1), and Coconut oil contains about 48.83 percent Lauric acid (12:0) and 19.97percent Myristic acid (14:0). Coconut oil has 94.73 percent of saturated fatty acid in it, which is the highest, followed by tallow which has 64.43 percent. Long-chain saturated fatty acid has very important for fue properties as it raises the cetane number and decreases NOx emissions (29,30). KV has a strong relationship with SFA, and HHV rises as SFA rises. The consistency of biodiesel is determined by a well-balanced mix of saturated and unsaturated fatty acids. Few studies show that Coconut has the lowest long-chain saturated factor (2.31) and Tallow has the highest (20.10).

Table 1. Fatty acid composition of biodiesel feedstocks

Name of oil	Oil content	Oil yield	Fatty acid composition										
			Myristic C14:0	Palmitic C16:0	Palmitoleic C16:1	Stearic C18:0	Oleic C18:1	Linoleic C18:2	Linolenic C18:3	Arachidic C20:0	Eicosenoic C20:1	Lignoceric C24:0	Ricinoleic C24:1
Neem	25-45	2670	0.2-0.26	14.9	0.1	20.6	43.9	17.9	0.4	1.6		0.3	
Waste cooking oil	-	-	0.41	0.822	0.89	5.61	48.83	10.94	2.68	0.56	0.97	-	-
Kusum	55-70		15.54	10.35	-	11.11	27.08	6.14	-	15.79	6.17	0.08	0.01
Rice bran			0.3	12.5	-	2.1	47.5	35.4	1.1	0.6	-	0.2	-
Moringa	33-41		0.1	2.9	1.7	5.5	74.1	4.1	0.2	2.3	1.3		
Corn	48	172	-	6.0	-	2.0	44.0	48.0	-	-	-	-	-
Jatropha	35-40	1892	-	14.2	-	6.9	43.1	34.3	0.3	0.3	-	-	-
Microalgae	70	136900	-	4.0-7.0	-	2.0-5.0	12.0-34.0	17.0-24.0	35.0-60.0	0.3-1.0	-	-	-
Cottonseed	18-20	325	-	28.3	-	-	75.4	10	-	-	-	-	-
Rapeseed	38-46	1190	-	3.5	-	0.9	64.1	22.3	-	-	-	-	-
Sunflower	25-35	952	-	6.4	0.1	4.76	22.52	52.34	8.19	-	-	-	-
Rubber	40-50	80-120	-	10.2	-	8.7	24.6	39.6	16.3	-	-	-	-
Karanja	27-39	225-2250	-	3.7-7.9		2.4-8.9	44.5-71.3	10.8-18.3	2.2-4.7	-	-	-	-
Tallow	-	-	-	29.0		24.5	44.5	-	-	-	-	-	-
Linseed	40-44	402	-	5.1	0.3	2.5	18.9	18.1	55..1	-	-	-	-

Physicochemical properties of biodiesel

Researchers have discovered that different growing conditions, such as species differences, soil environment, temperature, and extraction methods causes the same feedstocks to have different chemical properties. Table 2 compares the physicochemical properties of biodiesels made from feedstocks. Kinematic viscosity (KV) is a primary fuel property that influences air and fuel mixture, fuel atomization consistency, droplet size, jet penetration, fuel quality, and spray properties (Mofijur et al. 2017). A good KV can make a big difference in engine efficiency, as lower the value of kinematic viscosity causes faster engine wear and leakage. Higher KV of any petrol, on the other hand, can cause larger droplets while injection, affecting overall combustion efficiency and resulting in increased exhaust gas emissions. The fuel density determines the energy content of any fuel.

Feedstocks	Edible(E) or Non-edible (N)	Kinetic Viscosity (mm2/s)	Density (Kg/m3)	Higher heating Value (MJ/kg)	Acid Value (mg.KOH /g)	FP(o C)	CN
Tallow	N	46.37	929	38.9	1.07	201	56
Jatropha	N	37.00	932.92	38.20	15.6-43	240	38.0
Cottonseed	N	33.50	914.80	39.50	0.6-2.87	234	41.8
Moringa	N	43.33	897.50	38.05	8.62	268.5	67
Beauty leaf	N	56.74	964	38.10	36.26	224	57.3
Pongamia	N	64.00	970	29.90	5.4	206	54.5
Waste cooking oil	N	45.35	918.4	35.82	0.67-3.64	236	30
Rapeseed	E/N	38.30	906.2	39.70	2.70	246	37.6
Sunflower	E	37.10	916.10	39.60	0.2-0.5	274	37.1
Mustard	E	42.77	913.80	39.83	1.82	218	57.2

Corn	E	34.90	909.5	39.5	0.1-5.72	277	37.6
Coconut	E	28.80	913.9	31.25	2.22	266	60
Palm	E	40-33	913.90	40.80	6.9-50.8	275	42.0
Ricebran	E	38.00	920.05	41.10	23.09	184	51
Soybean	E	32.60	913.80	37.30	0.1-0.2	254	37.9
Peanut	E	39.60	902.60	49.80	0.15-0..20	271	41.8

Table 2. Physicochemical properties of biodiesel feedstocks

The energy content of any fuel is determined by heating value, and a high HHV is required for a diesel engine to improve combustion. The addition of antioxidants is necessaryto have appropriate oxidation stability as the minimum oxidation stability time should be 3 to 6 hours. Oxidation stability for Jatropha, Coconut, and Beauty leaf is 3.02 hrs., 9.2 hrs. and 3.58 hrs respectively which exactly met ASTM requirements. The flashpoint (FP) temperature of the fuel is a significant characteristic, and any normal fuel should have a high FP. According to findings, FP is inversely proportional to fuel volatility. Since petrol has a lower flash point than biodiesel, biodiesel is much safer to store and transport. All studied biodiesels meet the minimum requirements following all standards except Pongamia and Soybean.

Biodiesel quality

Biodiesel has a wide range of fuel properties and thus consistency, which is determined by the presence of unsaturated and saturated esters. Unsaturated methyl esters have lower oxidation stability as well as freezing points than saturated. Biodiesel that meets the standard quality as prescribed by ASTM-6751, IS 15607 and EN-14214 can be used in diesel engines with or without blending. Biodiesels which is having poor oxidation stability can also be used in diesel engines after adding Antioxidants and cold flow improvers (Dwivedi, Sharma, and reviews 2014). According to Indian, American, and European standards, the OSI limits are 8, 3, and 6 respectively. In cold weather situations, engines running on oils/biodiesels as fuels have starting and operability issues. The degree of unsaturation, as well as the length of fatty acid chains, determine the CFP of oils/biodiesel (Bhuiya et al. 2016). In cold weather, a lower CFPP of any biodiesel creates problems in engine use, but the same biodiesel can work fine in the tropical environment (Azad et al. 2014). The lowest temperature at which, when cooled under certain conditions, a certain volume of liquid fuel still moves through a standardized filtration system in a given amount of time is fuel to referred to as CFPP (Silitonga et al. 2013). For or obstruct the engine fuel system (Ong et al. 2013). There are no international guidelines for CFPP. The cetane number is a very important fuel characteristic that decides fuel's ignition and combustion efficiency. Fuel's specific gravity and heating value have a major impact on CN (Bhuiya et al. 2016). A higher CN fuel reduces the formation of white smoke and helps in smoother combustion with a quick cold engine start (44-45). Fuel with a lower cetane number leads to the formation of particulate matter and unburnt hydrocarbon as well as increased engine noise. Most of the biodiesel have comparable CN as that of diesel except the Soybean.

Oxidation stability refers to a biofuel's ability for being stable in its properties when kept for longer duration, and it's a major concern in terms of fuel stability and, consequently, engine efficiency (Lapuerta et al. 2008). The reaction of unsaturated fatty acids/esters with atmospheric oxygen produces hydroperoxide, sediments, and gums, all of which harm biofuel engine results. The oxidation stability of biofuels can be calculated using the OSI (Oxidation Stability Index) as shown below (Bhuiya et al. 2016).

Table 3. Valurs of CP and PP of of few feedstocks

S. No.	Edible and non-edible oils	%Fatty acids		CFP (°C)	
		Saturated	Unsaturated	CP	PP
1	Rapeseed	4.34	95.19	-6.57	-13.99
2	Linseed	8.8	91.5	-4.45	-11.69
3	Sunflower	9.34	90.66	-3.97	-11.16
4	Used frying oil	12	86	-1.28	-8.24
5	Soybean	15.34	83.05	0.42	-6.39
6	Peanut	17.2	82.7	0.62	-6.18
7	Ratanjyot	19.8	81.6	1.25	-5.49
8	Rubber	21.1	80.5	1.89	-4.79
9	Sesame	18	78	3.33	-3.234
10	Karanja	23.15	74.85	5.14	-1.26
11	Musturd oil	26	74	5.63	-0.73
12	Tallow	55	42.5	23.78	18.99
13	Neem	37.4	62.2	12.43	6.66
14	Mahua	47.9	57	15.42	9.91
15	Palm	48.30	50.8	18.99	13.79
16	Kusum	53.11	39.47	25.52	20.89
17	Coconut	78.5	9.1	43.01	39.89

FUTURE PERSPECTIVE

There are various sources of biofuel identified by the scientists and researchers so far, which include edible oil, non-edible oil, animal fats, microbial feedstocks, waste cooking oil, etc. making biodiesel viable for use and economical for production. The present work may be used by future researcher and have the following prospects:

- To contribute to identifying the most appropriate and cost-effective feedstocks for biodiesel selection for greater use.
- To find novel and abundant biodiesel feedstocks without compromising with the edible sources
- To give proper information and motivate people to accept biodiesel as an able replacement of fossil fuels.

CONCLUTION

The present work, emphasised on various selection criteria to choose better alternative out of the available biofuel resources. The available feedstocks for biofuel production has been categorised generation-wise as well as according to their origin. Free fatty acid in biofuel mainly decides the quality of biofuel and few of the biodiesel feedstocks was arranged in tabular form and their fatty acid composition was noted. Physicochemical properties of generally available feedstocks are also summarised briefly. These work will extensively contribute in identifying the most appropriate and cost-effective feedstocks for biodiesel selection for greater use. Waste cooking oil, because of its easy and wide availability and Tallow oil, because of its economical viability and being environmentally friendly fuel; are two important biodiesel feedstocks to be considered for mass production and future use as an alternative to fossil fuels.

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