A COMPREHENSIVE EXAMINATION OF VARIOUS EDIBLE AND NON-EDIBLE OILS

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ABSTRACT

There is widespread use of diesel and fossil fuels worldwide. In India, the increasing population and growing dependence on fossil fuels have led to a rise in their consumption, resulting in global warming and environmental pollution. Therefore, there is a need for an alternative solution. Biodiesel presents a promising substitute, as it helps reduce environmental contaminants. It is derived from edible and non-edible oils, as well as their blends. The extracted raw oil undergoes processing through transesterification, a process influenced by various parameters such as the type of catalyst used, the molar ratio of alcohol to oil, the type of alcohol, reaction temperature, and duration. This paper aims to review recent advancements and studies on biodiesel production in recent years.

Keywords: Transesterification, Catalyst Type, Extracted Oil, Parameters, Edible Oils, Fuel Sustainability, Reaction Parameters.

INTRODUCTION

Fossil fuel-based engines are widely used for transportation, and in the future, their usage could be reduced. Experts worldwide are seeking alternative solutions to fossil fuels. Brouwer et al. (2016) identified Azolla as one of the fastest-growing nitrogen-fixing plants on Earth, with the potential to produce high-quality biodiesel from its lipids. Dohaei et al. (2020) tested *Azolla filiculoides* and found a maximum lipid yield of 18.1%. Two protein extraction methods were used in this process: sequential extraction and sodium hydroxide methods. Gui et al. (2008) reviewed studies on biodiesel production from edible oils and stated that continued reliance on edible oils may lead to food-versus-fuel issues. Atabani et al. (2013) noted that edible oils are favored for biodiesel production due to their low free fatty acid content, among other factors, though they can be expensive. Consequently, investigating non-edible oils could lead to significant cost savings.

Abu-Hamdeh and Alnefaie (2015) conducted tests on a single-cylinder diesel engine under various load conditions using blends of almond and palm oil biodiesel. The results showed that the blends significantly increased exhaust gas temperature and thermal efficiency, while also improving performance and reducing brake-specific fuel consumption. Haile (2014) studied the use of coffee grounds for biodiesel production and the creation of pelleted fuel. The biodiesel production process achieved zero waste and resulted in a significant increase in brake thermal efficiency (BTE). Golzary et al. (2021) stated that Azolla, one of the fastest-growing water-based macrophytes, can double its growth in just two days. Its lipid content is found to be 11.7%, making it a potential feedstock for bio-refineries. Abd Manan et al. (2016) found that the highest yield of clove oil is significantly influenced by factors such as temperature and incubation time. Under optimized conditions, the highest yield (56.13%) occurred at 60°C with 6 hours of incubation time. Biocatalysts, which are environmentally friendly, were used in the production process.

Prabakaran et al. (2021) studied the transesterification of *Azolla pinnata* algae oil using a novel catalyst and found that it significantly decreased CO, HC, and smoke opacity emissions, but increased NOx emissions. Brake thermal efficiency decreased, and brake-specific energy consumption increased when compared to diesel at peak load conditions. Verma and Sharma (2016) examined the transesterification of linseed, sunflower, palm, and Panama oils using alkaline catalysts such as sodium and potassium hydroxides. They found that reaction temperature, molar ratio, and reaction time were the optimum parameters. Pikula et al. (2020) emphasized that fossil fuels remain the primary source of energy, although the volume of renewable energy sources is steadily increasing. Biodiesel production from microalgae lipids utilized enzymatic transesterification, non-catalytic supercritical transesterification, and microwave and ultrasound-assisted technologies.

Nautiyal et al. (2020) conducted experiments on biodiesel production from algae and found that the ignition delay period, as well as CO, HC, and smoke emissions, decreased significantly, while NOx emissions increased. Thiruvenkatachari et al. (2021) extracted oil from Azolla feedstock using the solvent extraction method and found that the biodiesel blend (B25) resulted in a significant reduction in CO, HC, and smoke emissions. The NOx value was lower compared to diesel. Kannan and Christraj (2018) selected Azolla algae for biodiesel production due to its high oil content, blending the extracted oil with Bao nanoparticles. The results showed that the addition of nanoparticles led to a significant reduction in emission parameters.

Yaşar and Altun (2018) studied biodiesel production from microalgae oil and found that the results were influenced mainly by physical properties such as kinematic viscosity, CFPP, density, and distillation temperature. Venkatraman et al. (2019) conducted experiments using Azolla oil methyl ester blends with ZrO2 nano additives in a single-cylinder diesel engine and observed a significant increase in NOx and a decrease in CO, HC, and smoke emissions compared to diesel. Narayanasamy and Jeyakumar (2019) extracted oil from Azolla algae using the Soxhlet extraction method and noted a significant decrease in brake-specific fuel consumption and an increase in brake thermal efficiency. NOx emissions increased, while CO, HC, and smoke emissions decreased. Subramaniam et al. (2020) conducted experiments on a single-cylinder direct-injection diesel engine and found that the results showed higher thermal efficiency and lower HC, CO, smoke, and particulate matter emissions. Bohlouli and Mahdavian (2021) stated that biodiesel is one of the most effective ways to reduce environmental pollutants and is compatible with diesel engines. Biodiesel production uses raw materials such as animal oil, vegetable oil, and recycled oil.

Thiruvenkatachari et al. (2022) investigated the effective use of biodiesel extracted from Azolla and found that brake thermal efficiency significantly increased, while emissions such as HC, CO, and smoke were significantly reduced at full load conditions. Ghannam et al. (2016) examined jojoba biodiesel and found that it had a higher flash point temperature, lower ash and sulfur content, and lower initial and final boiling temperatures. The velocity, acid number, and deposition rate were lower compared to diesel. Shaah et al. (2021) stated that biodiesel can serve as an alternative fuel for combustion engines. Non-edible oils are the primary feedstock for biodiesel production (Naik & Balakrishna, 2018). IU Khan (2024) used Ole ferrsines (OF) and *Nicotiana tobaccum* (NT) seeds in his study, finding that the oil content ranged from 30–49%, with a biodiesel yield of 96.4–97.9%. The transesterification process was used to determine the purity of the biodiesel and evaluate its performance parameters and properties.

RNV Boas and Mendes (2022) stated that biodiesel is an environmentally beneficial and non-toxic alternative fuel made from non-edible raw materials. Performance and emission metrics were calculated experimentally, and biodiesel was found to reduce emissions (Fattah et al., 2013). EP Venkatesan et al. (2023) reported that biodiesel, when combined with antioxidant additives, decreased emissions from CI engines. Rozina et al. (2022) noted that biodiesel made from non-edible seed oil is favored due to its efficiency and environmentally friendly properties. The analysis of non-edible seed oil fats ranged from 28% to 38%, while the free fatty acid content ranged from 0.56 to 2.06 mg. Jamil (2024) observed that the global demand for fuel is rising, and biodiesel, as a non-toxic, renewable substitute for petroleum fuel, is a viable alternative. Non-edible feedstocks do not compete with the food economy and are cost-effective (Melo et al., 2019).

The main objective of this study is to provide a comprehensive review of the literature on the use of various edible and non-edible oils to investigate emission, combustion, and engine parameters. The transesterification process is employed to extract biodiesel (Rakopoulos, 2013).

1. Bio-diesel

The use of biodiesel has significant advantages for the transportation sector. Edible and non-edible oils are used to make biodiesel, a green energy source. Emissions and pollution can be reduced by using less oil (Martin, 2010).

1.1 Types of Oils

The ability of biodiesel to meet three key requirements, price, environmental friendliness, and ease of use, determines whether it can be blended as a substitute for diesel fuel.

1.2 Edible Plant Oils

Edible plant oils have seen remarkable growth in recent years, driven by their widespread use in the food industry and as a key source of biodiesel. Countries like the US, Argentina, Brazil, Europe, Malaysia, and Indonesia have made it a common practice to use edible oils such as babassu, soybean oil, palm oil, rose seed oil, sesame oil, and sunflower oil as feedstock for biodiesel production. Table 1 shows the deviation in fatty acid content among various edible oils, while Table 2 shows the differences in the physical properties of these oils. Additionally, Table 3 shows the variation in the production of biodiesel from edible oils through the transesterification process.

1.2.1 Babassu

The seeds of the native South American babassu plant, found in the Amazon region, yield a translucent, pale yellow vegetable oil known as babassu oil. The fruit of the babassu tree is utilized in medicines and herbal treatments, as well as edible oil in cleaning and personal hygiene goods. Two batches of Babassu are manufactured annually. Thyroid function may be adversely affected by the fruit and other plant components of the babassu plant, particularly in those

Fatty Acid	Babassu	Soybean oil	Palm oil	Rapeseed oil	Sunflower oil	Sesame oil
Lauric Acid(C12:0)	47.40	0.1	0.1	0.1	0.1	---
Myristic Acid (C14:0)	15.54	0.1	1.0	---	0.1	---
Palmitic Acid (C16:0)	8.01	13.9	42.8	3.5	6.4	13.1
Palmitoleic Acid(C16:1)	0.02	0.3	---	---	0.1	---
Margaric Acid(C17:0)	0.02	---	---	0.1	0.1	---
Stearic Acid(C18:0)	3.15	2.1	4.5	0.9	2.9	3.9
Oleic Acid(C18:1)	11.28	23.2	40.5	64.1	17.7	52.8
LInoleic Acid(C18:2)	1.85	56.2	10.1	22.3	72.9	30.2
Linplenic Acid(18:3)	0.25	4.3	0.2	8.2	---	---
Arachidic Acid(C20:0)	0.05	0.3	0.4	0.4	0.6	---
Gonodoie Acid(C20:1)	0.05	---	0.2	2.1	0.7	---
Behenic Acid(C22:0)	0.01	0.1	0.1	0.3	0.3	---
Lignoceric Acid(24:0)	0.04	---	0.1	---	0.2	---
Saturates(%)	86.42	15.3	44.7	5.4	---	---
Unsaturates(%)	11.43	84.7	55.3	94.6	---	---
References	Melo et al. (2019)	Atadashi et al. (2010); Demirbaş (2003); Fattah et al. (2013)	Atadashi et al. (2010); Avhad and Marchetti (2015); Fattah et al. (2013)	Demirbaş, (2003); Fattah et al. (2013)	Demirbaş (2003)	Demirbaş (2003)

Table 1. Deviation of Different Fatty Acid Content of Edible Oils

Feed-stock	Density at 15°C (kg/m^3)	Kinematic Viscosity at 40°C (mm^2/sec)	Cetence number	Calorific value (MJ/kg)	Flash Point (°C)	Refs
Diesel	837	3	50	42.7	60-80	Naik and Balakrishna (2018); Rakopoulos et al. (2006)
Babassu	876.2	4	63.7	40.0	126	Kale and Ragit (2017)
Soybean	925	4	38	32.7	178	Atadashi et al. (2010); Rakopoulos et al. (2006)
Palm oil	870	4.5	50	37.2	135	Naik and Balakrishna (2018); Rakopoulos et al. (2006)
Rapeseed	885	4.7	53	37.3	170	Naik and Balakrishna (2018); Rakopoulos et al. (2006)
Sesame	920	4.0	36	39.34	260	Naik and Balakrishna (2018)
Sunflower	920	4.6	37	36.5	183	Rakopoulos et al. (2006); Rashid et al. (2008)

Table 2. Deviation of Different Edible Oils Physical Properties

Sample	Catalyst	Alcohol	Reaction Temp(°C)	Molar Ratio	Time Taken	Yield(%)	Refs
Babassu	KOH(1%W/W)	Methanol	50	6:1	60min	99.42	Kale and Ragit (2017)
Soybean	KOH(1%W/W)	Methanol	65	9:1	120min	97.6	Naik and Balakrishna (2018)
Palm oil	H_2SO_4 (1.85%W/W)	Methanol	60	25:1	120min	86	Naik and Balakrishna (2018)
Rapeseed	CAO(5%W/W)	Methanol	65	15:1	180min	99.2	Tang et al. (2013)
Sesame	NAOH(1%W/W)	Methanol	75	6:1	180min	100	Mahloujifar and Mansournia (2021)
Sunflower	NAOH(1%W/W)	Methanol	60	6:1	120min	97.1	Rashid et al. (2008)

Table 3. Deviation of Edible Oil to Bio-Diesel Production from Transesterification Process

who are hypothyroid. Babassu's fatty acid profile is Oleic Acid (C18:1) at 11.28 (Melo et al., 2019). If a more effective system for gathering fruits is used, the output in the actual baseline scenario can range from 1.6 million tons to 4.1 million tons annually. In natural stands, the net yield ranges from 20 kg/ha to 1,500 kg/ha.

1.2.2 Soybean

Soybeans are a staple food farmed all over the world, particularly in North America, South America, and Asia. Of the global production, 28% comes from Brazil and 32% from the United States (Sharma & Patel, 2018). Soybean oil is an edible oil. Although soybeans are grown year-round, the highest yields are typically seen from November through March, while April through October yields the lowest. Even in their immature green state, raw soybeans are toxic to all monogastric mammals. Soybean oil has an oleic acid (C18:1) profile of 23.2% (Demirbaş, 2003). The productivity and output of soybeans in India is 1035.4 kg/ha. India is a major producer of soybeans, primarily in Gujarat, Punjab, Madhya Pradesh, Uttar Pradesh, Maharashtra, and Delhi. Soybeans are processed to extract soybean oil, which is used both for human and animal consumption (Atadashi et al., 2010).

1.2.3 Palm Oil

The mesocarp of the fruit of oil plants is where palm oil is extracted, making it a vegetable oil. Several nations produce palm oil, including Nigeria, Colombia, and the leading oil-producing nations of Indonesia and Malaysia. Edible plant oil is derived from seeds, and palm oil is made from the mesocarp of these seeds. Palm oil flowers from June through August, while the fruit is harvested and packaged in March and April. Although the thorny fronds of the gago palm are more difficult for pets to consume than the seeds, which are more toxic to them, the plant remains dangerous. With an average production of 4 to 5 tons of crude palm oil per hectare, oil palm is the plant that yields the most edible oil, with oleic acid (C18:1) content of 40.5% (Atadashi et al., 2010). Oil palms typically produce 0.6–1 ton of oil per acre. In India, the top state for cultivating oil palm is Andhra Pradesh, which has a 20 lakh-ton output capacity. A total of 33.73 tons of palm oil are produced annually from the primary oil crops. Today, palm oil is a major source of sustainable and renewable raw materials for the world's food, oleo-chemical, and bio-fuel industries (Basiron, 2007). The Indian states of Andhra Pradesh, Telangana, Karnataka, Tamil Nadu, Odisha, Assam, and Mizoram are among those that produce palm oil. Additionally, the inner fruit layer of palm trees is used to make souvenirs such as candles, bottles, and mugs, while the husk is woven into mats and ropes (Demirbaş, 2003).

1.2.4 Rapeseed Oil

Rapeseed oil was one of the first vegetable oils. It is produced in many countries across the world, including China, India, France, and Canada. Rapeseed plants grow in a variety of climates, reaching heights of three to five feet. Rapeseed oil is edible. The rapeseed plants are harvested, with yellow flowers and black seeds. Rajasthan is the primary producer of rapeseed oil in India, with smaller production coming from Uttar Pradesh, Madhya Pradesh, and Haryana. Rapeseed, one of the Brassica family's yield-produced winter or spring annual crops, is rarely composed of this extremely poisonous material. The fatty acid profile of rapeseed oil is 64.1 for oleic acid (C18:1), and it also contains ferulic acid (Demirbaş, 2003). The yearly yield rate of rapeseed oil is 1,511 kg/ha in India and 1,979 kg/ha globally, according to (Chauhan et al., 2020). Waste is produced during the manufacture of new polyurethane composites.

1.2.5 Sunflower Oil

Sunflower oil is extracted from the sunflower seeds. The volume of sunflower seeds produced in Russia is substantial. With 53% of the world's total production, Russia and Ukraine lead the globe in sunflower seed production, which reached 50 million tons. Sunflower oil is edible oil. Sunflower seeds can be sown from September to November and sown for springtime from January until the end of February. Sunflower seed consumption in excess may result in issues with phosphorus overload, which can harm the kidneys and calcify non-skeletal tissues. Demirbaş (2003) Oleic acid (C18:1) 17.7 is the fatty acid profile of sunflower oil. This paper states that the yield of sunflower is 4340 kg/ha in chernozem soil and 4255 kg/ha in reddish preluvosoil. The cleaned sunflower seeds are placed in gunny bags after being thoroughly dried. When cultivated under irrigation, the sunflower crop yields 800-1200 kg/ha of grain, compared to 300–500 kg/ha when rain-fed. Karnataka, Odisha, Haryana, Maharashtra, Bihar, West Bengal, Telangana, Andhra Pradesh, and Uttar Pradesh are the states in India that produce the most sunflowers. Using a straightforward batch reactor conversion process, the harvested seeds are dried, stored in a grain bin, and then passed through an oilseed press to produce two byproducts: oil and meal. After processing, the oil from these crops is converted into an affordable, sustainable fuel in the form of biodiesel.

1.2.6 Sesame Oil

The world's largest producers of sesame oil are in China, India, Africa, and the Middle East (Olowe & Adeoniregun, 2010). Sesame oil is an edible oil extracted from seeds. The cropping months for sesame oil seeds are July, August, September, October, and November. The sesame plant can withstand a variety of climatic conditions and may be grown in dry regions, requiring less care during the crop-growing process. Sesame oil essentially contains no harmful ingredients. It is extracted from seeds using a mechanical press. The fatty acid profile of sesame oil is 52.8 for oleic acid (C18:1) (Demirbaş, 2003). The oil contains more unsaturated fatty acids. Sesame oil is produced from seaweed and harvested between July and November. The global sesame seed yield is 512 kg/ha annually (Myint et al., 2020). Sesame seeds are grown in several Indian states, including Tamil Nadu, Madhya Pradesh, Bihar, Karnataka, and Andhra Pradesh. Sesame seed production is a major industry in India. In many Asian countries, sesame oil is a staple in traditional cuisine.

1.3 Non-Edible Oil

Non-edible oils have gained increased attention due to their high oil content and the ability of non-edible oil plants to grow on barren or wasteland unsuitable for conventional agriculture. Additionally, these plants require minimal maintenance and can thrive in diverse atmospheric conditions, reducing the initial cost of cultivation. Table 4 shows the deviation of different fatty acid content of non-edible oils, while Table 5 shows the deviation of different non-edible oils' physical properties. Furthermore, Table 6 shows the deviation of non-edible oil to bio-diesel production from the transesterification process.

1.3.1 Jatropha Oil

Jatropha curcas is a flowering plant native to the American tropics, primarily Mexico and Central America,

Fatty acid	Jatropha	Cotton Seed	Castor Oil	Neem oil	Karnaja	Rubber seed
Lauric acid(12:0)	---	0.1	---	---	---	---
Myristic Acid(14:0)	4.6	0.7	---	0.2-0.26	---	---
Palmitic Acid(16:0)	14.2	20.1	1.2	13.6-16.2	3.7-7.9	10.20
Palmitoleic Acid(16:1)	1.4	---	---	---	---	---
Margaric Acid(17:0)	0.1	---	---	---	---	---
Stearic Acid(18:0)	6.9	2.6	1.2	14.4-24.1	2.4-8.9	8.70
Oleic Acid(18:1)	43.1	19.2	3.4	49.1-61.9	44.5-71.3	24.60
Linoleic Acid(18:2)	34.4	55.2	4.1	2.3-15.8	10.8-18.3	39.60
Linolenic Acid(18:3)	13.2	0.6	0.5	---	---	16.30
Arachidic Acid(20:0)	0.2	---	---	0.8-3.4	---	---
Gonodoie Acid(20:1)	0.2	---	---	---	---	---
Behenic Acid(22:0)	0.1	---	---	---	---	---
Lignoceric Acid(24:0)	2.6	---	---	---	1.1-3.5	---
Saturates	21.1	28.2	2.4	---	---	---
Unsaturates	78.9	71.8	97.6	---	---	---
Refs	Fattah et al. (2013)	Fattah et al. (2013)	Maleki et al. (2013)	Singh and Singh (2010)	Singh and Singh (2010)	Avhad and Marchetti (2015)

Table 4. Deviation of Different Fatty Acid Content of Non-Edible Oils

Feed-stock	Density at 15°C (kg/m³)	Kinematic Viscosity at 40°C (mm³/sec)	Cetence number	Calorific value (MJ/kg)	Flash Point (°C)	Refs
Jatropha	879	4.8	51	39.2	135	NPalit et al. (2011)
Cotton Seed	914.8	4	41.8	39.5	234	Rakopoulos (2013); Singh and Singh (2010)
Castor	959	15.17	48.9	37.20-39.5	145	Berman et al. (2011); Patel et al. (2016); Scholz and Da Silva (2008)
Neem oil	863.8	3.8	48.9	43	150	Madai et al. (2020)
Karanja	930	46- 5.52-5.59	39	39.12	230	Patel and Sankhavara (2017)
Rubber Seed	873	66.2	53	37.5	198	Ramadhas et al. (2005)

Table 5. Deviation of Different Non-Edible Oils Physical Properties

Sample	Catalyst	Alcohol	Reaction Temp(°C)	Molar Ratio	Time Taken	Yield(%)	Refs
Jatropha	KOH(0.55%W/W)	Methanol	60	5:1	24min	99	Moser (2009)
Cotton Seed	KOH(1.07%W/W)	Methanol	25	20:1	30min	98	Moser (2009)
Castor Oil	NI Droped ZNO Nano Catalyst(11%W/W)	Methanol	55	8:1	60min	95.20	Baskar et al. (2018)
Neem oil	KOH(0.5%W/W)	Methanol	70	9:1	20min	94.9	Muthu et al. (2010)
Karanja	KOH(1%W/W)	Methyl Ester	65	6:1	120min	97	Patel and Sankhavara (2017)
Rubber Seed	KOH(1%W/W)	Methyl Ester	55	6:1	67.5min	96.8	Ahmad et al. (2014)

Table 6. Deviation of Non-Edible Oil to Bio-Diesel Production from Transesterification Process

and belongs to the spurge family Euphorbiaceae. Originally found in tropical regions from Mexico to Argentina, it has since naturalized and expanded to other tropical and subtropical regions worldwide. The seeds of the Jatropha plant are inedible. While some plants produce two or three harvests during the winter, others continue producing throughout the season. If soil moisture is sufficient and temperatures remain high, multiple crops can be harvested throughout the year in addition to winter fruits (Nahar & Ozores-Hampton, 2011).

The toxicity of Jatropha extracts found in its fruit seeds, oil, roots, bark, latex, and leaves has been well documented across various species, including higher animals and microbes (Devappa et al., 2010). The fatty acid profile of Jatropha oil consists of 43.1% oleic acid (C18:1) (Fattah et al., 2013), with 21% of the seeds being saturated and 79% unsaturated. Jatropha seed production varies from approximately 0.13 to 4.86 tons per acre and 0.3 to 10.9 tons per hectare annually. Large areas of wasteland in India have been allocated for Jatropha cultivation, providing vital employment opportunities for rural communities. Major producing states in India include Andhra Pradesh, Kerala, Karnataka, Tamil Nadu, and Rajasthan. Jatropha oil is primarily used for biodiesel production, while Jatropha cake serves as a high-quality organic fertilizer, fish and animal feed, biomass feedstock for power generation, and a source for biogas.

1.3.2 Cotton Seed

Cotton is a soft, fluffy staple fiber that grows in a protective case around the seeds of Gossypium species in the mallow family (Malvaceae). The fiber is almost pure cellulose, with minor percentages of waxes, fats, pectin, and water. Under natural conditions, cotton bolls aid in seed dispersal. Cottonseed oil is produced in several countries, including China, India, Brazil, Pakistan, Turkey, the United States, Uzbekistan, and Turkmenistan. Cotton seeds are non-edible. Cotton is cultivated during the winter season, which generally has reduced cloudiness, but low temperatures near the winter solstice can limit its development (Grundy et al., 2020). Cotton fiber and oil production generate by-products rich in fat and protein, which are commonly used for animal feed. However, the plant contains a toxic compound. The fatty acid profile of cottonseed oil includes 19.2% oleic acid (C18:1) (Fattah et al., 2013).

Saleem et al. (2010) stated that the maximum yield of the plant is 69.3 grams globally. Cotton is one of India's main cash crops. Gujarat is the leading cotton-producing state, followed by Maharashtra, Tamil Nadu, Rajasthan, Karnataka, Andhra Pradesh, Haryana, Madhya Pradesh, Punjab, and Odisha. Meal, a byproduct of the oil extraction process, is fed to livestock. Most animals can be fed cottonseed meal, which is high in protein. Cotton seed hulls also serve as a good feed source for livestock.

1.3.3 Castor Oil

Castor plants are grown in arid and semi-arid areas. They are commercially cultivated in thirty countries, including China, India, Brazil, and Russia (Souza-Schlick et al., 2018). Approximately 88% of the world's castor seed supply comes from two major producers, Ethiopia and the Philippines. Castor seeds are inedible and classified as a kharif crop in India, sown from July to August, with arrivals beginning in December and continuing through March (Scholz & Da Silva, 2008).

Castor beans, which are rich in one of the most toxic substances known to man, can cause special and promote stomach reflux syndrome. Castor seed has a fatty acid profile of oleic (18:1) 3.4 (Maleki et al., 2013). The production rate of castor seed after 75 days is 3194 kg/ha (Souza-Schlick et al., 2018). Less of the crops that are regarded as traditional in Gujarat and Andhra Pradesh are grown in states like Rajasthan, Karnataka, Tamil Nadu, Maharashtra, and Orissa in India. The castor plant proved to be a lifesaver for everyone because it is an inedible plant that yields more bio-diesel than any other vegetable oil. (Baskar et al., 2018; Maleki et al., 2013). Castor oil cake, also known as castor oil meal, is a by-product of castor oil extraction that is high in protein. The fibrous by-product known as castor seed hulls or husks is another byproduct. The fact that poisonous chemicals are present in every section of the ricin-us communion plant is a significant problem (Berman et al., 2011; Patel et al., 2016).

1.3.4 Neem Oil

Neem oil, sometimes referred to as margosa oil, is a vegetable oil that is extracted from Neem fruits and seeds. The nations that manufacture Neem oil are the United States, Singapore, China, India, and Sri Lanka. The oil is derived from Neem seeds. The most popular oil right now is Neem. Oleic (18:1) 49.1 to 61.9 is the fatty acid profile of Neem oil (Singh & Singh, 2010).

Neem oil fruit ripens in the first week of July, but some trees still have green fruits in the third week of August. Neem oil consumption has the potential to be toxic and can result in metabolic acidosis, seizures, kidney failure, encephalopathy, and severe brain damage in infants and young children. Neem oil begins to bear fruit after five years and reaches full fruit production at the age of ten to twelve years fruit yield is 5-20 kg/tree per year in the initial years. The states in India that produce Neem oil include Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, Gujarat, Karnataka, Orissa, Tamil Nadu, Rajasthan, Punjab, and West Bengal (Chhabra et al., 2021). The crushed Neem seeds that are used to make oil are not wasted because, when dried, the cake that is left behind has nutrients that both nourish and act as an organic insecticide.

1.3.5 Karnaja

Karnaja trees reach a height of 15 to 25 meters, and they have huge crowns that produce tiny pink or white flowers in nearly every part of India. Karajan seeds contain a lot of oil. The Karnaja tree most likely originated in Australia, Southeast Asia, and India.

The seeds of Karnaja are inedible. Karnaja trees are commercially grown in India; the seeds are gathered in December and April after ripening from February to May. The oil extracted from karnaja seeds contains flavonoids that are harmful, such as 1.25% karnaja and 0.85% pongamol. However, following refinement, the oil's composition is similar to peanut oil and is free of bitterness and unpleasant smells. Oleic acid (18:1) 44.5-77.3 is the fatty acid profile of karanji oil (Singh & Singh, 2010).

It is unsuitable for use in agroforestry and generates a lot of root suckers. Seven years after planting, the karanji tree begins to bear fruit, reaching maximum production in ten years. It can yield 0–30 kilograms of seeds annually. Karnaja seeds are native to India and can be found in many different regions of the country. They typically grow along road edges, river banks, and the backyards of tribal and other forest-dwelling people in states like Andhra Pradesh and Odisha. Karnaja seed oil cake is a by-product of oil extraction that would otherwise be wasted because fertilizers are needed first to prepare activated carbon.

1.3.6 Rubber Seed

The different countries that produce rubber seeds: are Vietnam, Thailand, China, India, and the Philippines.Rubber seeds in inedible oil. India produces rubber seeds, which ripen between July and September. It is well known that a wide variety of plants can have poisonous seeds. The rubber plant is one such plant that has toxic components in its seeds. The rubber seed fatty acid profile Oleic acid (18:1) 24.60 (Avhad & Marchetti, 2015).

Rubber clones impact the amount of rubber seed produced, with the rate of generation varying from 150 to 1000 kg/ha annually. India contributes to over 16% of the world's rubber production, with 8.5 lakh hectares dedicated to rubber cultivation. Nearly 5 lakh hectares of this area are located in Kerala and Kanyakumari districts of Tamil Nadu, while 1 lakh hectares are in Tripura and the northeastern states, particularly Assam and Tripura. Kerala's share has decreased from almost 90% to 78%. The non-traditional regions of Maharashtra, Goa, and Karnataka together account for 6% of the total output. The by-product of rubber seed oil extraction, known as non-edible rubber seed cake, can be used to produce bio-oil.

Conclusion

Any edible and non-edible plant can be used to produce fuel if it has the right fatty acid structure. However, the choice of feedstock for biodiesel production should be based on factors such as fatty acid content, feedstock availability, plant yield, and feedstock cost. Therefore, edible seeds can be used for biofuel production, and edible seed waste can also be used for various purposes like animal and fish feeding. Edible oils do not produce toxicities. Non-edible seed oils, however, are not used for human consumption. The biofuel production potential of different edible and non-edible oils needs further investigation. Edible seeds are typically produced during certain seasons, while non-edible seeds are harvested in other seasons. The investigation primarily considers the fatty acid content and physical properties of these oils. Some oils have lower oleic acid content, while others have different proportions of saturated and unsaturated fatty acids. The physical properties mainly focus on cetane number; if the cetane number is less than 35, the oil is considered suitable for fuel. Biodiesel production involves the use of various catalysts and alcohols. Finally, the investigation focuses on non-edible oils for biofuel production, as they are not used for cooking or eating purposes.

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