

**STUDIES ON THE PROPERTIES OF KARANJA
OIL FOR PROBABLE INDUSTRIAL
APPLICATION**

*A Dissertation
Submitted in partial fulfilment for the degree of
MASTER OF SCIENCE IN CHEMISTRY*

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CERTIFICATE

This is to certify that the thesis entitled "**Studies on the properties of Karanja oil for probable industrial application**" which is being submitted by Ms. Rukhsar Alam to the Department of Chemistry, National Institute of Technology, Rourkela, for the award of Master of Science in Chemistry is a record of bonafied research work carried out by her under my guidance and has fulfilled the requirements for the submission of thesis, which is to my knowledge has reached requisite standard.

The results contained in this dissertation have not been submitted in part or in full to any university or institute for the award or any degree.

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1. ABSTRACT

Biodiesel (fatty acid methyl ester) which is derived from triglycerides by transesterification has attracted considerable attention during the past decade as a renewable, biodegradable and nontoxic fuel. Several processes for biodiesel fuel production have been developed, among which transesterification using alkali as catalyst gives high level of conversion of triglycerides to their corresponding methyl ester in a short duration. This process has therefore been widely utilized for biodiesel fuel production in a number of countries. In India, non-edible oils like karanja oil and jatropha oil are available in abundance, which can be converted to biodiesel. In the present studies, biodiesel has been prepared from karanja oil. As the acid values of this oil were more than 3, hence it can be converted to biodiesel by esterification followed by transesterification process. The methyl ester produced by these methods was analyzed to ascertain their suitability as diesel fuels. Then the comparison of physicochemical properties was done karanja oil, karanja oil methyl ester and biodiesel. The various properties of methyl esters are found to be comparable with that of diesel fuel. However it requires further studies for considering the product as a suitable biodiesel.

Keywords: Karanja oil, Biodiesel, Esterification and Transesterification

2. INTRODUCTION

In the last few years interest & activity has grown up around the globe to find a substitute of fossil fuel.. According to Indian scenario the demand of petroleum product like diesel is increasing day by day hence there is a need to find a solution. The use of edible oil to produce biodiesel in India is not feasible in view of big gap in demand and supply of such oil. Under Indian condition only non-edible oil can be used as biodiesel which are produced in appreciable quantity and can be grown in large scale on non-cropped marginal lands and waste lands. Non-edible oils like jatropa, karanja and mahua contain 30% or more oil in their seed, fruit or nut. India has more than 300 species of trees, which produce oil bearing seeds [1]. Around 75 plant species which have 30% or more oil in their seeds/kernel, have been identified and listed [2]. Traditionally the collection and selling of tree based oil seeds were generally carried out by poor people for use as fuel for lightning. Biodiesel has become more attractive because of its environmental benefits and fact that it is made up of renewable resources [3]. Although short term test using vegetable oil showed promising results, longer tests led to injector coking, more engine deposits, ring sticking and thickening of the engine lubricant [4].

Milletia pinnata is a species of tree in the pea family, Fabaceae, native in tropical & temperate Asia including parts of India, China, Japan, Malaysia, Australia & Pacific islands [5, 6]. It is often known by the synonym *Pongamia pinnata* and it was moved to the genus *Milletia* only recently. *Pongamia pinnata* is one of the few nitrogen fixing trees (NFTS) to produce seeds containing 30-40% oil. It is often planted as an ornamental and shade tree but now-a-days it is considered as alternative source for Bio- Diesel. This species is commonly called pongam, karanja, or a derivation of these names.

It is a legume tree that grows to about 15–25 meters (15–80 ft) in height with a large canopy which spreads equally wide. It may be deciduous for short periods. The leaves are soft, shiny burgundy in early summer and mature to a glossy, deep green as the season progresses. Flowering starts in general after 3–4 years. Cropping of pods and single almond sized seeds can occur by 4–6 years. Small clusters of white, purple, and pink flowers blossom on their branches throughout the year, maturing into brown seed pods. The tree is well suited to intense heat and sunlight and its dense network of lateral roots and its thick, long taproot make it drought-tolerant. The dense shade it provides slows the evaporation of surface water

and its root nodules promote nitrogen fixation, a symbiotic process by which gaseous nitrogen (N_2) from the air is converted into ammonium.



Figure 1: Karanja tree with fruits

2.1 Uses

2.1.1 Wood: pongam is commonly used as fuel wood. Its wood is medium to coarse textured. However, it is not durable, is susceptible to insect attack, and tends to split when sown. Thus the wood is not considered a quality timber. The wood is used for cabinet making, cart wheels, posts (NAS 1980), agricultural implements, tool handles and combs (GOI 1983).

2.1.2 Oil: A thick yellow-orange to brown oil is extracted from seeds. Yields of 25% of volume are possible using a mechanical expeller. The oil has a bitter taste and a disagreeable aroma, thus it is not considered edible. In India, the oil is used as a fuel for cooking and lamps. The oil is also used as a lubricant, water-paint binder, pesticide, and in soap making and tanning industries. The oil is known to have value in herbal medicine for the treatment of rheumatism, as well as human and animal skin diseases. It is effective in enhancing the pigmentation of skin affected by leucoderma. The oil of Pongam is also used as a substitute for diesel.

2.1.3 Fodder and feed: The leaves are eaten by cattle and readily consumed by goats. However, in many areas it is not commonly eaten by farm animals. Its fodder value is greatest in arid regions. The oil cake, remaining when oil is extracted from the seeds, is used as poultry feed.

2.1.4 Medicinal properties: Although all parts of the plant are toxic and will induce nausea and vomiting if eaten. The fruits and sprouts, along with the seeds, are used in many traditional remedies. Juices from the plant, as well as the oil, are antiseptic and resistant to pests. Like, neem oil, it is excellent for skin and hair and used in the manufacture of soaps, creams, lotions and other skin and hair care products. A mixture containing equal amounts of neem and karanja oil is very effective on animals for skin problems.

2.1.5 Other uses: Dried leaves are used as an insect repellent in stored grains. The oil cake, when applied to the soil, has pesticidal value, especially against nematodes and also improves soil fertility. Pongam is often planted in homesteads as a shade or ornamental tree and in avenue plantings along roadsides and canals. It is a preferred species for controlling soil erosion and binding sand dunes because of its dense network of lateral roots. Its root, bark, leaf, sap, and flower also have medicinal properties. The oil of the Karanja or Pongam is used in pharmacy and in agriculture. The wood is said to be beautifully grained but splits easily when sawn thus relegating it to firewood, posts, and tool handles. Its dense network of lateral roots makes this tree ideal for controlling soil erosion and binding sand dunes.



(a)



(b)



(c)

Figure 2: (a) Karanja fruit (b) Husk (c) Seed

2.2. MAJOR NON-EDIBLE OIL SEEDS

2.2.1 Mahua Seed [7, 13]

Mahua seed is also called as *Bassia Latifolia*, *Madhuca indica*. It is also known as Indian Butter Tree. Its oil cake is used as fodder, bio-fertilizer and organic manure. It is widely available in most of the state e.g. Orissa, Chhattisgarh, Jharkhand, Bihar, Madhya Pradesh and Tamil Nadu. It can be successfully grown in waste land and dry land. Its oil is edible and is similar to that of ground nut oil.

2.2.2 Jatropha [14]

It is also known as *Jatropha curcas*. It is drought resistant and grows well in poor soil. It grows quickly and produces seeds for 50yrs. It produces seeds with an oil content of 37%. Its oil cake is used as bio-fertilizer and organic manure.

2.2.3 Karanja [14]

It is medium sized tree and is found throughout India. The tree is drought resistant. Major producing countries are East Indies, Philippines, and India. The oil content varies from 27-39%. Its cake is used as pesticide and fertilizer.

3. LITERATURE

The use of vegetable oils as an alternative fuels has been known for 100yrs when the inventor of the diesel engine Rudolph Diesel first tested peanut oil, in his compression engine.

One possible alternative to fossil fuel is the use of oils of plant origin like vegetable oils & tree borne oils seeds. This fuel can be termed as Biodiesel. This fuel biodegradable & non-toxic & has low emissions profiles as compared to petroleum diesel. Usage of biodiesel will allow a balance to be sought between agriculture economic development & the environment.

Biodiesel is the monoalkyl esters of long chain fatty acids derived from renewable feed stocks, such as vegetable oil or animal fats, for use in compression ignition engine. Biodiesel, which is considered as a substitute for diesel fuel is commonly, composed of fatty acid methyl esters which can be prepared from triglycerides in vegetable oils by transesterification with methanol. The resulting biodiesel is quite similar to diesel fuel in its main characteristics.

The plant oil usually contains free fatty acids, phospholipids, water, odourants & other impurities. Because of these, the oil cannot be used as fuel directly. To overcome these problems the oil requires slight chemical modification mainly transesterification. Transesterification is the key & the foremost important step to produce the clear & environmentally safe fuel from vegetable oils. Chemically the oils/fats consists of triglycerides molecules of three long chain fatty acids. They differ by the length of carbon chains, orientation & position of double bond in these chains. Thus biodiesel refers to lower alkyl esters of long chain fatty acids which are synthesized either by transesterification with lower alcohols or by esterification of fatty acids.

Vegetable oils occupy an important position in the development of alternative fuels although there have been many problems associated with using it directly in engine. These include:

1. Carbon deposits.
2. Oil ring sticking.
3. Thickening or gelling of the lubricating oil as a result of contamination by vegetable oils,&
4. Lubricating problems.

Other disadvantages to the use of vegetable oils & especially animal fats are the high viscosity (about 11-17 times higher than diesel fuel), lower volatilities causes the formation of deposits in engine due to incomplete combustion .These problems are associated with large triglyceride molecules and its higher molecular mass and avoided by modifying the engine .

3.1. BIODIESEL

Biodiesel which is derived from triglycerides by transesterification and from the fatty acids by esterification has attracted considerable attention during the past decade as a renewable, biodegradable, eco-friendly and non-toxic fuel. Several processes for biodiesel fuel production have been developed. Biodiesel is recently used as a substitute for petroleum based diesel due to environmental considerations and depletion of vital resources like petroleum and coal. The possible use of renewable resources as fuels and as a major feedstock for the chemical industry is currently gaining growth. Further as petroleum is a fast depleting natural resource, an alternative renewable way to petroleum is a necessity. Now serious efforts are being made on the production and utilization of biodiesel in India. Methyl esters are clean burning fuel with no sulphur emission. Although its heat of combustion is slightly lower than that of the petro-diesel, there is no engine adjustment necessary and there is no loss in efficiency [7]. Methyl esters are non-corrosive and are produced at low pressure and low temperature conditions. Concentrated (about 80 %) glycerine is obtained as a by-product during transesterification process. Bradshaw [8] stated that 4.8:1 molar ratio of methanol to vegetable oil leads to 98% conversion. He noted that ratio greater than 5.25:1 interfered with gravity separation of the glycerol and added useless expense to the separation. Freedman, et al. [9] studied the effect of molar ratio of methanol to oil and effect of changes in concentrations of tri-, di- and monoglyceride on ester yield. Freedman et. al. [10] obtained the results for methanolysis of sunflower oil, in which the molar ratio varied from 6:1 to 1:1 and concluded that 98% conversion to ester was obtained at a molar ratio of 6.1. Biodiesel from karanja oil shows no corrosion on piston metal and piston liner whereas biodiesel from jatropha curcas has slight corrosive effect on piston liner [11]. In the present investigation, biodiesel was prepared from karanja oil and its properties were analyzed to ascertain its suitability as biodiesel.

This results in the formation of a tetrahedral intermediate. The reaction of this intermediate with an alcohol produces the alkoxide ion in the second step. In the last step the rearrangement of the tetrahedral intermediate gives rise to an ester and a diglyceride. The same mechanism is applicable to di-glyceride and monoglyceride.

4. OBJECTIVE

The increased demand of petroleum derived fuel as well as their resulting environmental concerns provides the incentives for the development of alternate fuels from renewable resources. Biodiesel derived from animal fat and vegetable oils can be used as diesel fuel substitute. The conventional method for the preparation of Biodiesel consists of alkali catalysed transesterification of the low free fatty acid (FFA) oil with methanol. Karanja is a non-edible oil seed grown throughout India is presently being underutilised. The by-products exhibit interesting biological activity. These can be used as insecticides & for various therapeutic uses.

Keeping the above facts in mind, the present work has been undertaken with the following objectives:

- The main aim of our project was to extract oil from karanja seeds,
- To find the constituents of the oil,
- To explore the preparation of biodiesel
- To find any other uses.

5. EXPERIMENTAL

5.1 Extraction of oil:

The seeds were grinded into fine particles & 50gms of the grinded seed was taken and a thimble was made. The soxhlet apparatus was set up as shown below. 300ml of hexane was added to thimble from above.



Figure 3: Soxhlet Extractor

Working of the apparatus:

A Soxhlet extractor is a piece of laboratory apparatus invented in 1879 by Franz Von Soxhlet. Typically, a Soxhlet extraction is only required where the desired compound has a limited solubility in a solvent, and the impurity is insoluble in that solvent. Normally a solid material containing some of the desired compound is placed inside a thimble made from thick filter paper, which is loaded into the main chamber of the Soxhlet extractor. The Soxhlet extractor is placed onto a flask containing the extraction solvent. The Soxhlet is then equipped with a condenser.

The solvent is then heated to reflux. The solvent vapour travels up a distillation arm and floods into the chamber housing the thimble of solid. The condenser ensures that any solvent vapours cool, and drips back down into the chamber housing the solid material. The chamber containing the solid material is slowly filled with warm solvent. Some of the desired compounds then get dissolved in the warm solvent. When Soxhlet chamber is almost full, the

chamber is automatically emptied by a siphon side arm, with the solvent running back down to the distillation flask. This cycle is allowed to repeat several times within 8hrs of extraction. During each cycle, a portion of the non-volatile compound dissolves in the solvent. After many cycles the desired compound is concentrated in the distillation flask. After extraction the solvent is removed, typically by means of a rotary evaporator at 40-50°C, yielding the extracted compound i.e. oil. The non-soluble portion of the extracted solid remains in the thimble, which is discarded.

5.2 Biodiesel Preparation

The experimental setup is shown in figure -4 A 2000 ml three-necked round-bottomed flask was used as a reactor. The flask was placed in a water bath, whose temperature could be controlled within ± 2 °C. One of the two side necks was equipped with a condenser and the other was used as a thermo well. A thermometer was placed in the thermo well containing little glycerol for temperature measurement inside the reactor. A blade stirrer was passed through the central neck, which was connected to a motor along with speed regulator for adjusting and controlling the stirrer speed [15].

Esterification: A known amount of karanja oil was taken in the above-mentioned setup. Required amount of sulphuric acid and methanol were added to the oil and stirred continuously maintaining a steady temperature of 64°C. Intermittently samples were collected at regular intervals (30min) and acid value was determined. After the confirmation of complete reduction of acid value to less than 1.0, the heating was stopped and the products were cooled. The unreacted methanol was separated by separating funnel. The remaining product was analyzed for acid value and it was found that the acid value varied from 1.0 to 0.5. This oil sample was for transesterified to obtain methyl esters.

Transesterification: In the same setup, known amount of esterified karanja oil was charged. Required amount of catalyst NaOH was dissolved in methanol and the rest amount of methanol along with the catalyst solution was added to the oil sample. After proper closing of the flask it was put on the water bath. The system was maintained airtight to prevent the loss of alcohol. The reaction mix was maintained at temperature just above the boiling point of the alcohol i.e. around 70°C to speed up the reaction rate. Excess alcohol was used to ensure total conversion of the oil to its esters.

After the confirmation of completion of methyl ester formation, the heating was stopped and the products were cooled and transferred to a separating funnel. And lower glycerol layer was separated. The oil was then washed several times with hot distilled water until the water didn't turned pink under further addition of phenolphthalein indicator. To the Biodiesel formed anhydrous sodium sulphate was added & left overnight to absorb moisture. The Biodiesel formed was then decanted.



Figure 4: Biodiesel Reactor

5.3 Determination of Acid Value:

The acid value was determined by directly titrating the material in an alcoholic medium with aqueous KOH solution. Free fatty acid was calculated as oleic acid.

Reagents:

Ethyl alcohol- ninety five percent by volume & neutral.

Phenolphthalein indicator- 1gm of phenolphthalein dissolved in 100ml of ethyl alcohol.

Standard aqueous KOH solution.

Procedure:

0.5gm of oil was weighed in a conical flask. 20ml of ethyl alcohol was added. To it 1ml of phenolphthalein was added. The mixture was boiled for 5mins & titration was carried out as hot as possible.

Calculations:

$$\text{Acid value} = \frac{56.1 \text{ VN}}{W}$$

Where,

V= volume in ml of standard KOH used.

N= normality of standard KOH.

W= weight in grams of the oil.

$$\text{Free fatty acids in terms of oleic acid, percentage by weight} = \frac{56.1 \text{ VN}}{W}$$

5.4 Determination of Unsaponification Value:

The material is completely saponifiable with alcoholic KOH solution & extracted with petroleum ether. This extract was evaporated and the residue was weighed. Unsaponifiable material is this residue- the fatty acid present in it.

Reagents:

Alcoholic KOH solution: 8gms of KOH was dissolved in equal quantity of water and then ethyl alcohol was added to it up to 100ml. It was allowed to stand overnight & then decanted.

Ethyl alcohol.

Phenolphthalein indicator solution.

Procedure:

5gm of oil was weighed in a flask. To it 50ml of KOH solution was added. It was boiled gently under reflux condenser for 2hrs. The condenser was washed with 10ml of ethyl alcohol. The mixture was cooled & transferred to a separating funnel. The transfer was completed by washing the flask first with ethyl ether and then with cold water. Altogether 50ml of water was added. This was followed by an addition of 50ml of hexane. It was shaken vigorously for 2mins & then allowed to settle. The lower layer containing the soap solution was transferred to another separating funnel & the ether extraction was repeated for five more times. If any emulsion is formed small amount of ethyl alcohol was added.

All the ether extract was collected in a separating funnel. This was washed three times with 25ml portions of alcohol shaking it vigorously & drawing off alcohol water layer after each washing. It was then washed with 20ml portions of water until the wash water no longer turns pink on addition of few drops of phenolphthalein indicator solution. The ether layer was evaporated to dryness. It was cooled & weighed. After weighing residue was taken in 50 ml of warm neutral ethyl alcohol containing few drops of phenolphthalein indicator solution & is titrated with standard KOH solution.

Calculations:

$$\text{Unsaponifiable matter, percent by weight} = \frac{100(A-B)}{W}$$

Where,

W= weight in grams of the oil taken for the test.

A= weight in grams of the residue.

B= weight in grams of the fatty acid.

$$=0.282VN$$

V= volume in ml of standard KOH solution used.

N= normality of standard KOH solution.

5.5 Determination of Iodine Number:

The material was treated in carbon tetrachloride medium with a known excess of iodine monochloride solution in glacial acetic acid (Wij's solution). The excess of iodine monochloride was treated with KI and the liberated iodine estimated by titration with sodium thiosulphate.

Reagents:

Potassium dichromate, concentrated HCl, KI solution, starch solution, standard thiosulphate solution.

Procedure:

0.4gm of the oil was taken in a flask & 25ml of CCl₄ was added to it. Then 25ml of Wij's solution was added to it. After mixing it properly 5ml of conc. HCl & 15ml of 10% KI solution was added. It was allowed to stand for 30mins. It was then titrated with standard sodium thiosulphate solution, using starch as an indicator.

Calculations:

$$\text{Iodine value} = \frac{12.69(V_2 - V_1)}{W}$$

Where,

V₁= volume of thiosulphate consumed for the test.

V₂= volume of thiosulphate consumed for the blank test.

W= weight in grams of the oil taken.

5.6 Determination of Saponification Value:

The oil was saponified by refluxing with a known excess of alcoholic KOH solution. The alkali consumed for saponification was determined by titrating the excess alkali with standard HCl.

Procedure:

2gm of sample was weighed in a conical flask. 25ml of alcoholic KOH was added to it. It was refluxed for one hour. It was boiled gently until the sample was completely saponified. The flask and condenser was cooled & then washed with about 10ml of hot neutral ethyl alcohol. 1ml of phenolphthalein was added and then titrated with standard HCl solution.

Calculations:

$$\text{Saponification value} = \frac{56.1(B-S)N}{W}$$

Where,

B= volume in ml of standard HCl required for the blank.

S= volume in ml of standard HCl required for the sample.

N= normality of standard solution.

W= weight in gram of the oil taken.

5.7 Characterization

The characterisation of oil is physical, chemical and thermal properties. Physical properties include Viscosity, Density, Cloud Point, Pour Point, Flash point and chemical properties comprise Iodine Value, Acid Value, Saponification Value, Unsaponifiable matter, Sulphur content, Water content, Sediment residues, Cupper strip corrosion.

5.7.1 Physical Test: These are the following physical tests:

1. Volatility is the major determinant of the tendency of hydrocarbon to produce potentially explosive vapours. The important tests are:-

- Flash point
- Fire point

2. For combustion properties:

- Cetane number

3. Test to determine tendency of certain petroleum products to melt or liquefy, to solidify wax like materials are:

- Freezing point
- Cloud point
- Pour point

4. Other tests:-

- Carbon residue
- Density
- Specific gravity
- Water content

5.7.2 Chemical Test: These are the following chemical tests:

1. Most of oils are corrosive. Test to determine it are:

- Sulphur content
- Copper strip corrosion

6. RESULTS AND DISCUSSION

6.1 Seed Characterisation:

Moisture content = 0%

Oil content = 34.87%

6.2 Percentage yield of oil:

The extraction of oil from karanja seeds were done by different methods, i.e. mechanical expeller, solvent extraction and cold percolation method using n-hexane as solvent and their yields are given in the table-1 below:

Table-1: Percentage yield of oil from karanja kernel

Extraction Method	Yield in %
Mechanical expeller	22
Cold Percolation	21
Soxhlet Extraction	32

6.3 Fatty Acid composition of Karanja oil:

The percentage composition of fatty acids present in karanja oil was determined by GCMS and is represented in the table-2 below:

Table-2: Fatty acid composition of karanja oil determined by GCMS

Fatty Acid	Molecular formula	Percentage	Structure
Palmitic acid	C ₁₆ H ₃₂ O ₂	11.65	CH ₃ (CH ₂) ₁₄ COOH
Stearic acid	C ₁₈ H ₃₆ O ₂	7.5	CH ₃ (CH ₂) ₁₆ COOH
Oleic acid	C ₁₈ H ₃₄ O ₂	51.59	CH ₃ (CH ₂) ₁₄ (CH=CH)COOH
Linoleic acid	C ₁₈ H ₃₂ O ₂	16.64	CH ₃ (CH ₂) ₁₂ (CH=CH) ₂ COOH
Eicosanoic acid	C ₂₀ H ₄₀ O ₂	1.35	CH ₃ (CH ₂) ₁₈ COOH
Dosocasnoic acid	C ₂₂ H ₄₄ O ₂	4.45	CH ₃ (CH ₂) ₂₀ COOH
Tetracosanoic acid	C ₂₄ H ₄₈ O ₂	1.09	CH ₃ (CH ₂) ₂₂ COOH
Residual		6.83	

Extracted oil consisted of 94.09% pure triglyceride esters and rest were free fatty acids and lipid associates, particularly flavonoids, which is the measure of unsaponifiable matter.

6.4 Physico-chemical properties of oil:

The physicochemical properties of karanja oil are shown in the table-3 given below:

Table-3: Physico-chemical Properties of Karanja oil

Properties	Value
Water Content	0.05%
Specific Gravity	0.9366
Density	0.9358 gm/cc
Carbon Residue	0.80%
Ash Content	0.05%
Flash Point	212 ⁰ C
Fire Point	224 ⁰ C
Copper Strip Corrosion	No corrosion was observed
Acid Value	16.8
Iodine Value	86.5
Boiling Point	330 ⁰ C
Sediments (insoluble in hexane)	0.006%
Cloud Point	2 ⁰ C
Pour Point	-4 ⁰ C
Calorific Value(Kcal/kg)	8742
Cetane Number	38
Saponification Value	85.7
Unsaponifiable matter	0.90%

6.5 Comparison of fuel properties of Karanja oil, Karanja oil methyl ester and Diesel:

Comparison of fuel properties of karanja oil, karanja oil methyl ester was done with diesel and the results are shown in the table-4 given below:

Table-4: Comparison of fuel properties of karanja oil, karanja oil methyl ester and diesel

Properties	Unit	Karanja oil	Karanja oil methyl ester	Diesel
Density@ 15 ⁰ C	gm/cc	0.9358	0.797	0.850
Viscosity@ 40 ⁰ C	cm ² /s	38.8	7.0	2.6
Flash Point	⁰ C	212.0	97.8	70.0
Cloud Point	⁰ C	2.0	-7	-16
Pour Point	⁰ C	-4	-6	-20
Water Content	%	<0.05	0.03	0.02
Ash Content	%	0.05	0.02	0.01
Carbon Residue	%	0.8	0.35	0.17
Sulphur Content	%	0.025	Nil	-----
Acid Value	mg of KOH/gm	16.8	0.42	0.35
Iodine Value		86.5	91	-----
Saponification Value		185.7	180.0	-----
Calorific Value	Kcal/kg	8742	3712	4290
Cetane Number		38.0	42.9	46

7. OTHER USES OF KARANJA

- Its fruits are used in abdominal remedies.
- Its seeds are used in tumor treatment.
- Oil is used for curing rheumatism.
- Leaves are used against Micrococcus.
- Their leaves juices are used for the treatment of diarrhea cold and cough.
- It has curative effect for leucoderma and itches.
- Its oil is used as a lubricant, water paint binder.

Utilization of Seed Cake

- As a Manure for having the proper N, P & K content and ratio.
- As a material for biogas (Methane) production.
- As a Material for Producing Proteins for Food, Pharmaceutical and Industrial Applications by Chemical and Biochemical Technologies.
- Production of Soluble Fibers for Food Uses.

8. CONCLUSIONS

Thus this study suggests that the karanja oils can be used as a source of triglycerides in the manufacture of biodiesel by esterification and or transesterification. The biodiesel from refined vegetable oils meets the Indian requirements of high speed diesel oil. But the production of biodiesel from edible oil is currently much more expensive than diesel fuels due to relatively high cost of edible oil. There is a need to explore non-edible oils as alternative feed stock for the production of biodiesel non-edible oil like karanja is easily available in many parts of the world including India and it is cheaper compared to edible oils. Production of these oil seeds can be stepped up to use them for production of biodiesel.

The production of biodiesel from these oil provides numerous local, regional and national economic benefits. To develop biodiesel into an economically important option in India biotechnological innovations to increase the seed yield are essential.

9. FUTURE WORK

- To study the efficiency of biodiesel with different blends of biodiesel.
- To find the various constituents responsible for effective use.
- To find the proper utilization of by-product.
- To improve the quality of biodiesel.
- To produce biodiesel from different non-edible oil.

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