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PRODUCTION OF BIODIESEL FROM A POTENTIAL BIOFUEL CROP MANIHOT ESCULENTA (CASSAVA) A NON EDIBLE OIL SEED AND ITS CHARACTERIZATION METHODS

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Research Paper

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ABSTRACT

Diesel plays an essential role in the industrialized economy of every country. High demand of energy and the fossil fuel spread in industrialized countries will lead to the rapid exhaustion of the resources of fossil fuel and the deterioration of the environment. Because the world's petroleum exploration is so erratically distributed and many regions must rely on others for their fuel needs. The unfamiliar crisis connected with petroleum fuels has forced the modern world to look for feasible alternative fuels. Among the possible alternatives, biodiesel has been recognized as a feasible front runner for many reasons. Biodiesel is composed of long chain fatty acid methyl ester (FAME) obtained by responding triglyceride with lower alcohols like ethanol and methanol in the presence of strong bases. KOH is utilized as a catalyst in the generation of biodiesel. Methanol is used for biodiesel production via trans esterification process. Biodiesel is extracted from the *Manihoit esculenta* seed oil via trans esterification process. Fuel analysis and GCMS test were conducted for the biodiesel. Gross calorific value, specific gravity and viscosity are the parameters were checked for fuel analysis of biodiesel. The composition of generated biodiesel was discovered via GCMS technique. The chemical and physical analysis of cassava seed oil were observed.

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Keywords: Biodiesel, *Manihoit esculenta* Oil, Extraction, Transesterification, Alternative Fuel.

INTRODUCTION

The unfamiliar crisis connected with petroleum fuels has forced the modern world to look for feasible alternative fuels. Research around the world has been enhanced firstly to mark the key crisis connected to alternative fuel. Identifying the right raw materials, economic feasibility, efficient processing and use are important issues that scientists are addressing. Among the possible alternatives, the biodiesel has been recognized as a feasible front runner for many reasons. Biodiesel is composed of long chain fatty acid methyl ester (FAME) obtained by responding triglyceride with lower alcohols like ethanol and methanol in the presence of strong bases (Fig 1). Another element is the quantity and distribution of defendable raw material inception recognized for the production of biodiesel. Animal fats, used edible oils, plant seed oils and vegetable oils are some of the approved inception for the biodiesel production. The accessibility of these staples is geographically more uniform than petroleum diesel. Technically, biodiesel can rival with petroleum diesel without crucial engine changes.

Diesel fuel plays an essential place in the industrialized economy of every country. High demand of energy and the fossil fuel spread in industrialized countries will lead to the rapid exhaustion of the resources of fossil fuel and the deterioration of the environment. Because the world's petroleum exploration are so erratic distributed, many regions must rely on others for their fuel needs. The

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biggest negative effect of petroleum – based fuels is the degradation of air quality owing to emissions. All of these considerations need the continuing search for and development of environmental friendly renewable sources of energy. Biomass sources, notably vegetable and seed oils, have gotten a lot of press as a potential alternative source of energy. They are non – toxic, renewable and may be made locally using plant and agricultural resources. Their use has no negative environmental consequences because they produce fewer greenhouse gases and toxic pollutants.

Greasy corrosive methyl esters is an effective, clean, 100% common vitality elective to petroleum powers. Among the numerous focal points of biodiesel fuel incorporate the taking after : secure for utilize in all routine diesel motors, offers the same execution and motor solidness as petroleum diesel fuel, non-combustible and non-harmful, diminishes tailpipe emanations, unmistakable smoke and harmful exhaust and odors. The utilize of biodiesel has developed significantly amid the final few a long time. Feedstock costs account for an expansive percent of the coordinate biodiesel generation costs, counting capital fetched and return.

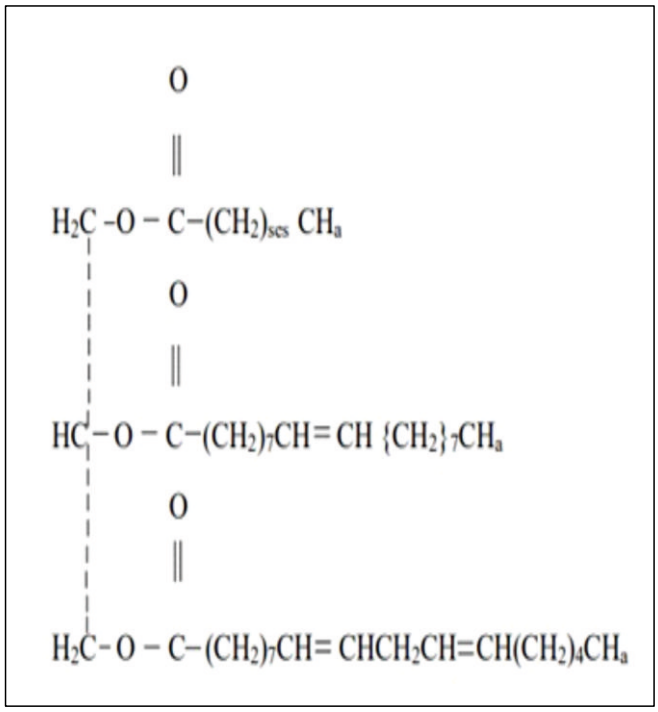

Fig. 1: Structure of a typical triglyceride molecule.

In this paper *M. esculenta* seed is used in the production of biodiesel. The scientific name is *Manihot esculenta* (Fig 2). As of late, *M. esculenta* has picked up noticeable quality as biofuel feedstock, eminently for the generation of biodiesel. It has ended up a major trade product in see of its large starch substance, which makes it a reasonable crude fabric not as it were for the generation of biodiesel, but moreover for bioethanol generation and numerous other businesses such as mash, material, nourishment and refreshment etc. *M. esculenta* tuber is handled in to an assortment of items counting starch, flakes, chips, peeler, pellets, cubes etc., but seeds are non-edible and are discorded as waste.

Fig. 2: *M. esculenta* Plant.

Here, the *M. esculenta* seed is utilized in the generation of biodiesel. Oil is extracted from the *M. esculenta* seed and by the process of transesterification the *M. esculenta* seed oil is converted into biodiesel.

MATERIAL AND METHOD

Feedstock Material

Manihot esculenta Seed Collection and Preparation

M. esculenta seeds were collected from Calicut, Kerala. The mature *M. esculenta* plant contain mature green capsules were harvested between December 2021 and February 2022. Each green capsules containing three cassava seeds. These cassava seeds looks like black beetles. The seeds were sun dried for 4-7 days after removing from the capsules. The seeds were crushed into powdered form and kept in the hot air oven about 1 – 2 hour on 60°Cand was stored in an air tight glass bottle(11).

Experimental Section

Oil Extraction from *M. esculenta* Seed

Solvent extraction process was followed for the oil extraction to achieve highest oil yield. 250ml of Petroleum ether was taken in a clean round bottom flask and the Soxhlet apparatus was setup (Fig 3). 50g of seed powder packet was taken into the extractor and allowed the extraction to carryout for 4 hours. After extraction was complete, mixture was kept for drying overnight to remove the solvent leaving behind *M. esculenta* oil (Fig 4). The oil collected was stored in a clean bottle for further analysis and processes.(14).

Fig. 3: Soxhlet extraction.

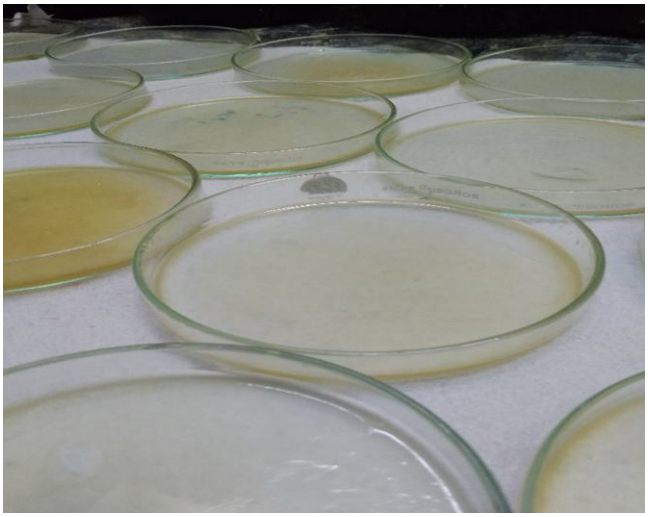

Fig. 4: Extracted oil left in petriplates.

Transesterification Process

Before the transesterification reaction, 1g NaOH was weighed and dissolved in 60 ml of methanol in a beaker. About 30 ml of stored *M. esculenta* seed oil were taken in a 250 ml conical flask and was kept in water bath for 10-15 minutes at 50°C. Add the alcoholic NaOH solution into the conical flask containing oil with constant stirring in the water bath for 2 hours. After 2 hours, transfer the mixture into a separating funnel, allow it to cool and 2 layers are formed where top layer contain FEMA and bottom layer was glycerin and unreacted methanol (Fig 5). The bottom layer was drained and 10-20 ml of distilled water was added to wash biodiesel for residual glycerin, methanol and sodium hydroxide.(11,14).

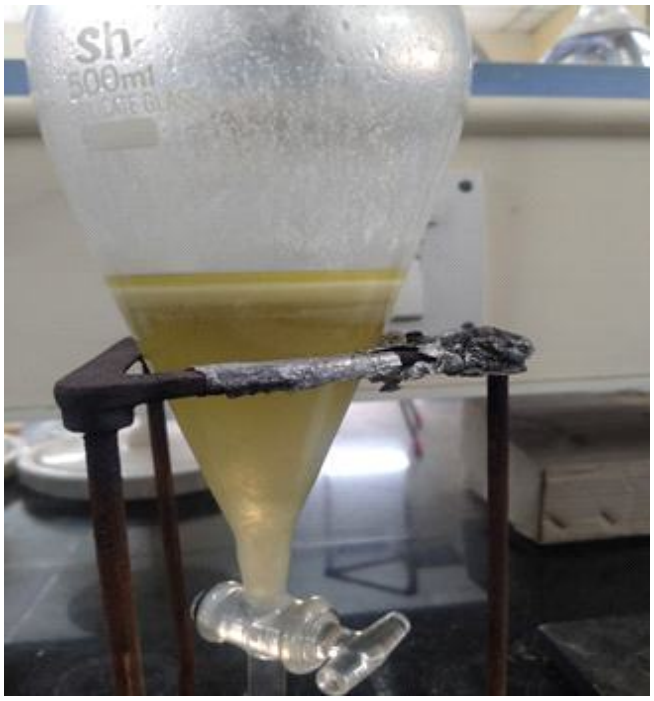

Fig. 5: Layer of biodiesel and glycerin.

Product Analysis or Characterization

The chemical and physical characteristics of oil and oil parameters were observed. The sample (biodiesel) characterization was carried out through GCMS test. Fuel analysis of the sample were observed.

RESULTS AND DISCUSSION

Amount of oil yield:

M. esculenta tubers are edible but the seed a discord. The seeds are rich with oils, upon solvent extraction good quantity of yield was expected. The oil obtained was light yellow in color for every 50g of seed powder was taken and obtained approximately 10 ml of oil. The percentage yield of oil was 20.23$\pm$0.46%.

Physical and Chemical Analysis of Oil

The characterization of oil is done by finding its density, total suspended solid, pH and total volatile solid.

Table 1: Physical and Chemical Analysis.

SL. NO	TEST NAME	RESULT
1	Density	0.8356 Kg/L
2	pH	Neutral
3	Total Suspended Solid	0.66 mg/L
4	Total Volatile Solid	0.94

Oil Parameters

The oil is subjected to parameters checking. They are acid value and free fatty acid value, saponification value, iodine value and peroxide value.

Table 2: Oil Parameters.

Sl. No	Test Name	Result
1	Acid Value	3.45 KOH/g
2	Free Fatty Acid Value	1.40%
3	Saponification Value	213. 18 mgOH/g
4	Iodine Value	1.66 wijs
5	Peroxide Value	14.0546 meq/1000g

Fuel Analysis

The biodiesel produced from the *M. esculenta* seed oil is checked for the fuel analysis. Gross Calorific Value, Viscosity and Specific Gravity is checked for the analysis of biodiesel.

Table 3: Fuel Analysis.

Test Name	Unit	Result	*Azadirchta excelsa*	*Tabebuia rosea*
Gross Calorific Value	Cal/g	9189	10,540	10,079
Specific Gravity at 260 C	_	0.8725	-	0.8729
Viscosity at 400 C	cst	4.69	6.17	3.99

Gross Calorific Value

Gross Calorific Value (GCV) and Higher Heating Value (HHV) are same. GCV is for the solid fuels and the Higher Heating Value is for the fluid fuels. It speaks to the warm of combustion when all combustion items are brought to the reactants temperature, condensing all water vapor. Heating value could be an exceptionally noteworthy attribute about diesel powers, since it allows vitality substance about combustible. Warming esteem be communicated being net and net calorific esteem, based through level about water display inside debilitate. In event that the water display being fluid, at that point warming esteem is GCV. In event that the water is display as vapor, at that point the warming esteem is called the NCV. Here water show as fluid. Unit of GCV is Cal/g. The Gross Calorific Value (GCV) of biodiesel is 9189.

Specific Gravity

The specific gravity of powers is utilized as an antecedent for a number of further attributes about fuel, such being warming esteem, cetane number, viscosity. The specific gravity is the proportion about thickness about a material toward thickness about a given allusion fabric. SG for fluids is about continuously measured with regard to water as it is densest. For gases, the reference is discuss at room temperature. Here, the specific gravity is calculated at 26^0C. The specific gravity of biodiesel is 0.8725.

Viscosity

Viscosity be allied to foremost critical parameter about methyl ester. Since it affect fuel infusion hardware, particularly in cold climate, therefore the consistency increments as the rise in temperature. The fuel which is as well profoundly viscous can lead harm within the fuel pump due to higher weight. As well very small viscosity may cause to a need of grease. Ordinarily, viscosity about methyl ester was irrelevantly overhead that about routine diesel combustible at 40^0C. Be that as it may, at a smaller temperature, the viscosity of biodiesel inclined greater particularly underneath 25^0 C. The unit of viscosity is cst. cst is centistokes. The viscosity is measured at 40^0C. The value of the viscosity of biodiesel is 4.69.

GCMS

Considering lesser semi vaporous and vaporous biomolecules like alcohols, aromatics and hydrocarbons in addition to fatty acids, pesticides, hormones and steroids, the gas chromatography (GC) remain bifurcation method as preferred, accomplishing this conclusive method natural in abounding implementation fields and industry sections, notably being environmental and food safety examination. GC-MS perchance utilized toward quantify analytes, complex mixture separation, unfamiliar peaks identification and assess trace levels of contagion while paired along the disclosure ability of the mass spectrometry (MS). GC-MS perchance utilized to investigate solid, liquid and gaseous samples. The biodiesel sample were tested for GCMS via Agilent Technologies.

Through the GCMS test method, the components present in the sample were detected. About 9

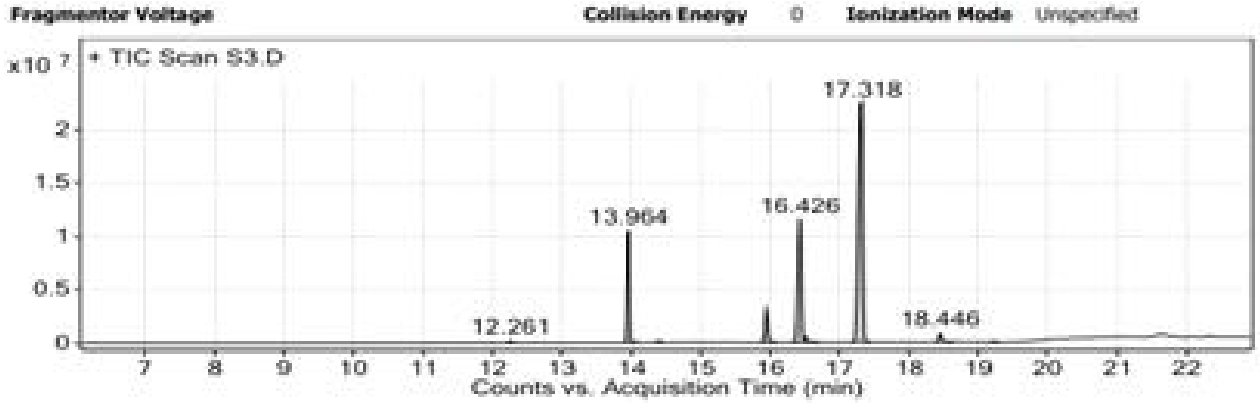

Fig. 6: GCMS Graph

components were exist in the sample. The components present are 1)Methyl tetradecanoate 2)Hexadecanoic acid, methyl ester 3)9-Hexadecenoic acid, methyl ester, (Z)- 4)Methyl stearate 5)9-Octadecenoic acid (Z)-, methyl ester 6)11-Octadecenoic acid, methyl ester 7) 9,12-Octadecadienoic acid (Z,Z)-, methyl ester 8)9,12,15-Octadecatrienoic acid, methyl ester, (Z,Z,Z)- 9)cis-13-Eicosenoic acid, methyl ester –(15).

Table 7: GCMS

SL.NO	COMPOUND	RETENSION TIME(MIN)	PERCENTAGE (%)
1	Methyl tetradecanoate	12.261	74.1
2	Hexadecanoic acid, methyl ester	13.964	74.1
3	9-Hexadecenoic acid methyl ester,(Z)-	14.395	55.1
4	Methyl stearate	15.943	74.1
5	9-Octadecenoic acid (Z)-, methyl ester	16.426	55.1
6	11-Octadecenoic acid, methyl ester	16.518	55.1
7	9,12-Octadecadienoic acid (Z,Z)-, methyl ester	17.318	81.1
8	9,12,15-Octadecatrienoic acid, methyl ester,(Z,Z,Z)-	18.446	79.1
9	cis-13-Eicosenoic acid, methyl ester	19.215	55.1

CONCLUSION

This study makes clear that the generation of biodiesel from *M. esculenta* seed oil is possible. The petroleum fuels will lead to many problems. The petroleum fuel is a non-renewable resource. So, the continuous utilization of petroleum fuel will causes the complete removal of the resource. In order to prevent the depletion of the resource an alternative fuel is required. The emanation from the petroleum fuel will leads to the pollution of atmosphere. The air pollution will affect all living organisms. The best choice as an alternative fuel is the methyl ester. Methyl ester is an inexhaustible origin of fuel. Biodiesel is generated from natural substance. That's why the biodiesel generated is environmental friendly. The biodiesel obtained from the *M. esculenta* seed oil will cause only less pollution to atmosphere, when compared to petroleum fuels. Biodiesel will helps toward reduce the pollution of air and harmful affects to the living organisms. The emanation of gases from the biodiesel that leads to the pollution of air is less when compared to the gases generate from petroleum fuel. When compared to other diesel fuels, biodiesel is cost effective. It can be generated from natural feedstock. Because of this natural feedstock, the biodiesel is environmental friendly. The results of Gas Chromatography Mass Spectrometry and Fuel Analysis test confirm that the biodiesel generated were successful in all terms. Through the fuel analysis test; gross calorific value, specific gravity and viscosity about methyl ester were identified. By GC-MS method the composition of the biodiesel were identified. 9 components of the biodiesel were discovered via GC-MS. The biodiesel generated from the *M. esculenta* seed oil were able to utilize as a substitute combustible.

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