

**Production of FAME Using Waste Papaya seeds by  
Different Experimental Conditions in a Batch System**Kamini A.Patel<sup>1</sup>, Milap G. Nayak<sup>2</sup>

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**Abstract**— An increase in the price of the petroleum, Biodiesel is one of the alternative fuels to diesel engines that could be moderately or fully replace or reduce the use of petroleum diesel fuel and produced from renewable biological sources. The seeds are generally discarded in order to make more efficient use of Papaya. It is important investigating the use of seeds as source of oil. Mechanical extraction technique is used to extract oil. There are four primary ways to produce biodiesel, direct use and blending, Microemulsion, thermal cracking (pyrolysis) and transesterification. The most widely used method is transesterification reaction Because of Trans-esterification reaction is reducing the viscosity during the production of biodiesel. The purpose of this method is to reduce the viscosity of oil using base catalyst in the presence of methanol. So, Trans-esterification reaction is use to produced Fatty acid methyl ester (FAME) from papaya seeds oil at different experimental conditions. The parameters are; mass ratio of ethanol to oil, reaction temperature, catalyst concentration, and reaction time. Analyzed papaya seeds oil and FAME. Fatty acid methyl ester Properties are found and that close to diesel fuel and also meet the specifications of ASTM standards.

**Key words**— Biodiesel Feedstock, Oil Extraction & Production of FAME, Analysis of oil & FAME sample, Characteristics of FAME.

**I. INTRODUCTION**

The main important for protecting global environment and long term energy security, necessary to develop alternative fuels and those properties comparable to petroleum based fuel. Biodiesel based fuels are renewable, non-toxic and safe to store, because of their oxygen content, the combustion is more complete and less carbon monoxide emission. There is a number of nonedible tree based oil seeds available in many countries around the world and from that biodiesel can be produce [1].

There are different ways to produced biodiesel with different kinds of raw materials likes refine crude or frying oils. Also there are different types of catalyst, basic ones such as sodium or potassium hydroxides, acids such as sulfuric acid, ion exchange resins, lipases and supercritical fluids. One of the advantages of this fuel is that the raw materials used to produce it are natural and renewable. All these types of oils come from vegetables or animal fat, making it biodegradable and nontoxic [2].

High emissions of CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, particulate matter, poly aromatic hydrocarbons and hydro-carbons are produced during the using of fossil fuel and creating environmental problems. These facts have converged in the search for renewable energy sources, such as biofuels- bioethanol and biodiesel [3].

**1.1. Advantage of Biodiesel**

Biodiesel is the only alternative fuel that runs in any conventional, unmodified diesel engine. Maintain the payload capacity and range of conventional diesel engines. Diesel skilled mechanics can easily attend to biodiesel engines. Exhaust emissions are lower. Biodiesel fuel is non-toxic and biodegradable.

**1.2. Disadvantage of Biodiesel**

Quality of biodiesel depends on the blend thus quality can be tampered. Biodiesel has excellent solvent properties. There may be problems of winter operability. Spills of biodiesel can decolorize any painted surface if left for long.

**II. MATERIAL AND METHODS****2.1. Food Waste**

Food Waste is an inheritable consequence of the food industry. Food industry produces large volumes of wastes, both solids and liquid because of production, preparation and consumption of food. These wastes increasing disposal and potential severe pollution problems and signify a loss of valuable biomass and nutrients. The wastes contain valuable components such as: sucrose, glucose, fructose and other Nutrients. Fruit pulp wastes after extracting juices are one of the major byproducts of food processing industries. Byproducts of food processing plant represent a major disposal problem for the industry concerned, but they are also promising sources of biomaterials. These biomaterials can be used as substrates for bioethanol production [4].

## **2.2. Feedstock: Papaya seeds**

Carica papaya originated in Central America. It contains many biologically active compounds. Two important compounds are chymopapain and papain, which are supposed to aid in digestion. Carica papaya could be a rich source of dietary fiber which can have beneficial effects. Papaya is important for its fruit and it is only recently that it has been cultivated purpose. Seeds of papaya fruits are discarded, because of bad experiences when they are consumed by humans or animals. The papaya seed oil contained 10.3% free fatty acid [5].

The papaya seed is currently a waste product as it is often discarded after eaten the papaya fruits due to its very limited uses at the moment. Papaya seed are recently gaining importance due to its medicinal value. The seed had recently been linked to curing sickle cell diseases, poisoning related renal disorder, and as an antihelminthes. There are scarce information's on this relatively underutilized seed despite its importance [6].

## **2.3. Use of Papaya seeds:**

### **2.3.1. Prevents from Parasites:**

The seeds of papaya fruit contain high levels of proteolytic enzyme just like papain which protects the body from parasites and their eggs as well as breaks down the protein wastes.

### **2.3.2. Kills Parasitic Worms:**

Papaya seeds also have an anthelmintic alkaloid known as carpaine which can kill the parasitic worms and amoebas.

### **2.3.3. Treats Liver Cirrhosis:**

Papaya seeds help to treat the liver cirrhosis (a disease caused by the excessive consumption of alcohol). Liver becomes hard and shrink and unable to remove toxins from the body which in turn cause serious health problems. Grinded papaya seed (four or five) can be taken by mixing with a tablespoon of lime juice for a month and twice a day to get relieve from the symptoms of liver cirrhosis. If taken regularly, helps in liver detoxification and improve its vital functioning.

### **2.3.4. Kills Harmful Bacteria:**

Papaya seeds have antibacterial and anti-inflammatory effects on digestive system by killing harmful bacteria like Salmonella, Staphylococcus, E. coli and others causing hazardous infections.

### **2.3.5. Prevents from Kidney Failure:**

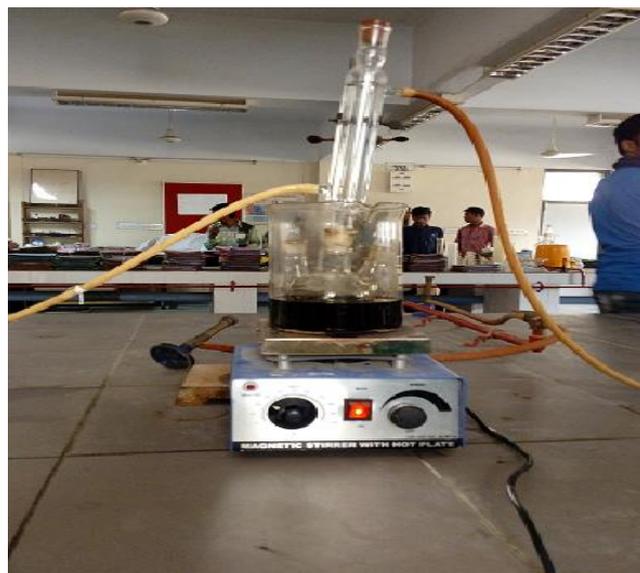
Seeds of papaya protect the kidney from kidney failure caused by the toxins [7].

## **2.4. Oil Extraction:**

Papaya seeds are discarded after eaten the papaya fruits. The seeds were collected from the different households as one discards the seeds after consuming the fruit. The collected seeds were dried. Dry Papaya seeds are raw material for extract of oil using mechanically hand press expeller.



*Figure 1. Mechanical Hand press Expeller*



*Figure 2. Trans-esterification Reaction*

## **2.5. Trans-esterification Reaction:**

Papaya seeds Oil is used into trans-esterification reaction and that reaction carried out in a batch system. In this experiment, Methanol as an alcohol and NaOH as a catalyst. First mix catalyst in alcohol upto NaOH dissolve into methanol. At that moment preheat the oil-bath upto constant temperature reached. Therefore, Add oil into 3-neck round bottom flask and mixture of methanol plus NaOH and provide continuous stirring using magnetic stirrer. Allow the reaction mixture to react for different time interval. After completion of Reaction take out mixture from 3-neck round

bottom flask and pour into the separating funnel and take a time to be settle. When two layers are appeared, in which upper layer is Biodiesel and lower layer is Glycerol. Collect both layers and Find out the yield of biodiesel.

The trans-esterification reaction carried out at different Experimental conditions. For different alcohol to oil molar ratio 3:1, 6:1, 9:1, 12:1, reaction temperatures are 50, 55 & 60°C and reaction times are 60-90-120min and catalyst concentrations are 0.5, 1, and 1.5%. Various experiments perform and Find Yield. Perform the Experiment and concluded that 2% and 4% of NaOH catalyst concentration used at that time Soap formation occurs and difficult to Separate Two phase of Biodiesel and glycerol.

### III. RESULTS AND DISCUSSION

#### 3.1. Trans-esterification reaction:

Different experiment performed at different conditions to give best yield and that condition: 0.5% catalyst concentration, 120min reaction time, Temperature 60°C and 9:1 alcohol to oil molar ratio to obtain best yield is 96.7%.

#### 3.2. Analysis of papaya seeds Oil and FAME:

##### 3.2.1 FTIR Analysis:

The FTIR spectra of papaya seed oil and the optimal biodiesel fuel were measured for two purposes; the first is for the qualitative determination of some of the obtained characteristic bands, the second is for the quantitative determination by monitoring the Trans-esterification reactions. The main differences observed between the infrared spectra of papaya seed oil and the produced biodiesel fuel are a small displacement of the stretching C=O band and stretching C-H band as well as the C-H bonding band of the biodiesel to the lower energy. This is attributed to the substitution of the glycerol by the methoxy radical (Fig 4-5).

##### 3.2.1. GC-MS Analysis:

Gas chromatography is used to separate mixtures into individual components using temperature controlled capillary column and Mass spectroscopy used to identify the various components from their mass spectra and each compound has a unique mass spectrum that can be compared with mass spectral database and thus identified. Shown GC-MS Analysis in below Fig 5. Figure in which Molecular formula and Formula name and Mol % are obtain GC-MS graph of FAME from Library-NIST11s.lib.

Sr no	R. Time	I. Time	F.Time	Area	Area%	Height	Height %	A/H Name	Base peak	MW	Formula	F.Name	Mol %
1	13.266	13.24	13.315	1149289	0.21	973786	1.23	1.18	74	242	C15H30O2	Myristic acid methyl ester	0.21
2	13.689	13.655	13.705	167715	0.21	108561	0.14	1.54	74	296	C19H36O2	5-Octadecenoic acid methyl ester	0.21
3	13.738	13.72	13.765	80989	0.01	62711	0.08	1.29	74	296	C19H36O2	5-Octadecenoic acid methyl ester	0.01
4	13.814	13.79	13.845	268103	0.05	232975	0.3	1.15	74	256	C16H32O2	Pentadecenoic acid methyl ester	0.05
5	14.25	14.19	14.3	4012826	0.73	2092645	2.65	1.92	55	268	C17H32O2	Palmitoleic acid methyl ester	0.73
6	14.418	14.31	14.54	51009800	9.28	9602681	12.17	5.31	74	270	C17H34O2	Palmitic acid methyl ester	9.28
7	14.74	14.72	14.775	551460	0.1	419262	0.53	1.32	55	296	C19H36O2	Oleic acid methyl ester	0.1
8	15.525	15.12	15.575	441136030	80.27	32235866	40.86	13.68	81	296	C19H36O2	Elaidic acid methyl ester	80.27
9	15.587	15.58	15.605	240032	0.04	335269	0.42	0.72	67	294	C19H34O2	Linoleic acid methyl ester	0.04
10	15.689	15.675	15.71	676158	0.12	754523	0.96	0.9	67	294	C19H34O2	Linoleic acid methyl ester	0.12
11	15.754	15.725	15.775	903881	0.16	500293	0.63	1.81	69	296	C19H36O2	Oleic acid methyl ester	0.16
12	16.069	16.035	16.095	2719302	0.49	1783992	2.26	1.52	55	348	C23H40O2	8,11,14-Docosatrienoic acid methyl ester	0.49
13	16.145	16.105	16.18	8005115	1.46	4832958	6.13	1.66	55	324	C21H40O2	11-Eicosenoic acid methyl ester	1.46
14	16.231	16.205	16.255	6426530	1.17	5003682	6.34	1.28	74	326	C21H42O2	Arachidic acid methyl ester	1.17
15	16.306	16.29	16.33	510965	0.09	424601	0.54	1.2	155	340	C20H36O4	Ethyl stearate diepoxy	0.09
16	16.464	16.445	16.485	448381	0.08	342072	0.43	1.31	55	334	C22H38O2	Cyclopropanoic acid	0.08
17	16.624	16.605	16.66	365668	0.07	251242	0.32	1.46	74	340	C22H44O2	Heneicosanoic acid methyl ester	0.07
18	16.733	16.705	16.755	306289	0.06	177931	0.23	1.72	95	308	C20H36O2	methyl 1,2-octylcyclopropene	0.06
19	16.851	16.83	16.875	439064	0.08	344178	0.44	1.28	55	884	C57H104O	9-octadecenoic acid propanetriyl ester	0.08
20	16.94	16.92	16.96	273398	0.05	234669	0.3	1.17	55	352	C23H44O2	13-Docosenoic acid methyl ester	0.05
21	17.038	17	17.065	10760961	1.96	6537889	8.29	1.65	74	354	C23H46O2	Docosanoic acid methyl ester	1.96
22	17.402	17.385	17.42	670819	0.12	615368	0.78	1.09	74	368	C24H48O2	Tricosanoic acid methyl ester	0.12
23	17.72	17.685	17.42	5739370	1.04	3480435	4.41	1.65	55	884	C21H40O4	9-Octadecenoic acid ethyl ester	1.04
24	17.793	17.765	17.82	5451897	0.99	4168858	5.28	1.31	74	382	C25H50O2	Tetraecosanoic acid methyl ester	0.99
25	18.186	18.16	18.2	159230	0.03	150761	0.19	1.06	74	396	C26H52O2	Pentacosonic acid methyl ester	0.03
26	18.23	18.21	18.255	660176	0.12	559701	0.71	1.18	69	410	C30H50	Squalene	0.12
27	18.626	18.6	18.655	485301	0.09	366957	0.47	1.32	74	410	C27H54O2	Hexacosanoic acid methyl ester	0.09
28	19.926	19.895	19.96	414309	0.08	222454	0.28	1.86	165	430	C29H50O2	Vitamin E	0.08
29	20.849	20.805	20.91	863997	0.16	349590	0.44	2.47	400	400	C29H48O	ampesterol	0.16
30	21.086	21.035	21.155	714060	0.13	286052	0.36	2.5	55	412	C29H48O	Stigmasterol	0.13
31	21.596	21.535	21.645	3928589	0.71	1450314	1.84	2.71	414	414	C31H52O2	sitosterol acetate	0.71

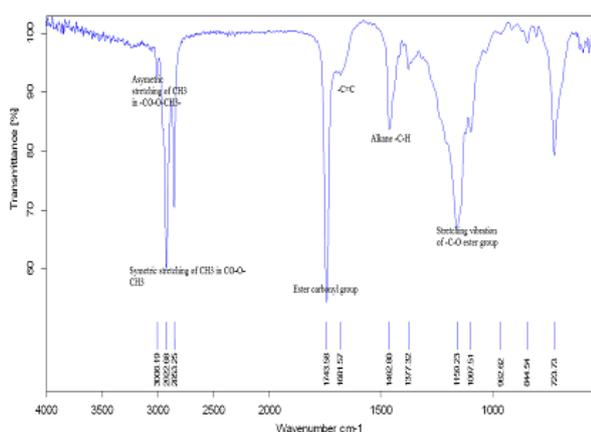
*Figure 3. GC-MS data for FAME Sample*

**Characteristics Properties of FAME:**

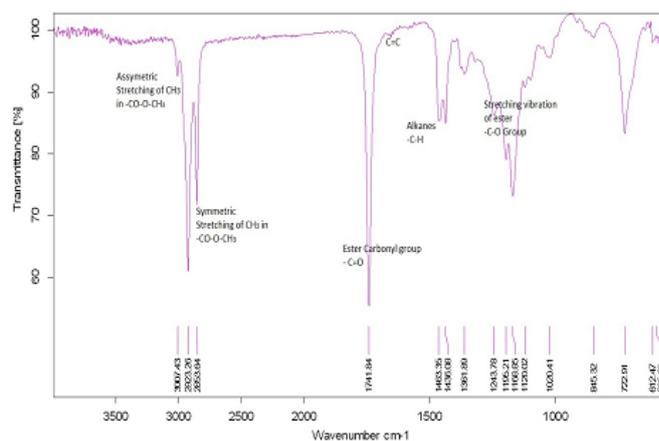
Characteristics Properties are found using ASTM Method and Properties value related to standard so we can use as Biodiesel.

**Table 1: Characteristics Properties of FAME**

Sr No	Properties	Value	Unit	Test Name
1	Acid value	0.03	mg KOH/g	ASTM D664
2	Kinetic viscosity	3.57	mm <sup>2</sup> /s	ASTM D445
3	Flash point	389	K	ASTM D93
4	Density	0.82	gm/ml	ASTM D4052

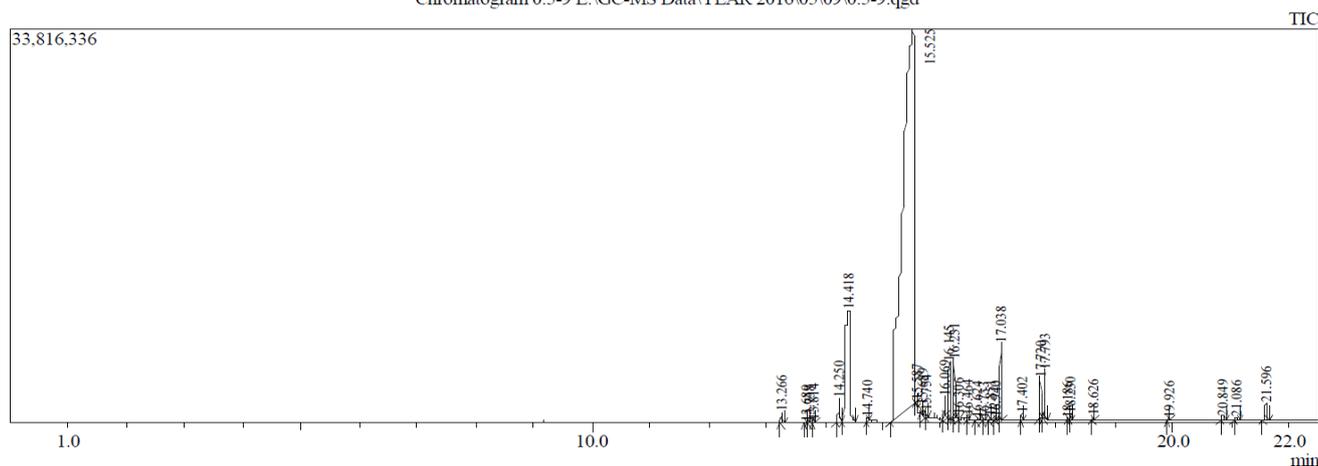


**Figure 4: FTIR Analysis of Papaya seed oil**



**Figure 5: FTIR Analysis of FAME**

Chromatogram 0.5-9 E:\GC-MS Data\YEAR 2016\05\09\0.5-9.qcd



**Figure 6. GC-MS Analysis of FAME**

**CONCLUSION**

Biodiesel is a mono-alkyl esters of fatty acids derived from vegetable oil or animal fat. Biodiesel is much less polluting than petroleum diesel, resulting in much lower emissions of every pollutant like carbon dioxide, sulfur oxide, particulates, carbon monoxide, air toxics and unburned hydrocarbons. Papaya seeds are discarded after eaten papaya. Mechanical method is relatively low yield obtain compared to chemical method but purity of oil is high compared to chemical method to extract oil. Best Yield Conditions is :0.5% catalyst concentration,120 min reaction time, Temperature 60°C and 9:1 alcohol to oil molar ratio to obtain best yield 96.70 %.Characteristics Properties are relevant to standard Biodiesel B100.Finally we concluded that Biodiesel of papaya seeds are Suitable for replacement of petrodiesel without any change of diesel engine.

**REFERENCE**

- [1] S. Bojan and S. Durairaj, "Producing biodiesel from high free fatty acid *Jatropha curcas* oil by a two-step method-an Indian case study," *Journal of Sustainable Energy & Environment*, vol. 3, pp. 63–66, 2012.
- [2] A. P. Vyas, J. L. Verma, and N. Subrahmanyam, "A review on {FAME} production processes," *Fuel*, vol. 89, no. 1, pp. 1 – 9, 2010.
- [3] A. Demirbaş and H. Kara, "New Options for Conversion of Vegetable Oils to Alternative Fuels," *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, vol. 28, no. 7, pp. 619–626, 2006.
- [4] M. Jayaprakashvel, S. Akila, M. Venkatramani, S. Vinothini, S. Bhagat, and A. Hussain, "Production of Bioethanol from Papaya and Pineapple Wastes using Marine Associated Microorganisms," *Biosciences, Biotechnology Research Asia*, vol. 11, no.Special edition, pp. 193–199, 2014.
- [5] I. S. Afolabi, G. D. Marcus, T. O. Olanrewaju, and V. Chizea, "Biochemical effect of some food processing methods on the health promoting properties of under-utilized *Carica papaya* seed," *Journal of Natural products*, vol. 4, pp. 17–24, 2011.
- [6] H. Syed, S. Kunte, B. Jadhav, and R. Salve, "Extraction and characterization of papaya seed oil," *Int J Appl Phys Bio-Chem Res*, vol. 2, pp. 33–43, 2012.
- [7] <http://www.womenplanet.in/health-fitness/benefits-of-papaya>