iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** V **Month of publication:** May 2018

DOI: http://doi.org/10.22214/ijraset.2018.5361

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue V, May 2018- Available at www.ijraset.com

Synthesis of Chicken Fat Methyl Ester

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Abstract: Today automobile industries are focusing on global warming and saving non-renewable resources. Biodiesel is one of the best solutions for this problem. Biodiesel is an alternative to conventional diesel fuel made from renewable resources such as vegetable oils/Chicken fat. According to the survey of Oil and Gas journal the high viscosity liquid fuel approximately 20 times that of diesel produced from chicken fat. The present study is focused on investigation of CI-Engine by using biodiesel which is produced from chicken fat.

The best chicken fat was collected from hotels and the butcher shop, this waste chicken fat was taken to extract oil from it and that oil is used in the production of biodiesel. This biodiesel obtained was then mixed with conventional diesel in different proportions to form blends and then these blends were tested on CI-Engine at different engine loads. Biodiesel production is modern and technological for researcher due to constant increase in the price for petroleum diesel and environmental advantages. The disposal of waste chicken creates environmental pollution, hence it is decided to extract oil from the waste chicken fat and produce biodiesel through trans esterification process. The studies are conducted on transesterification process for chicken fat biodiesel blends of B20, B25, B30, B35, B40, B50, B100. The fuel consumption test of a constant speed CI engine is also conducted to evaluate the performance of the engine on diesel and chicken fat biodiesel blends. The characterization of fuel is analysed by plotting graphs and important property like specific gravity of biodiesel blends were compared with the fossil diesel and 100% biodiesels. The fuel characterization includes the fuel properties like viscosity, density, calorific value and flash and fire point.

I. INTRODUCTION

Energy paucity in transportation sector as well as expeditious environmental contention necessitates the sustainable diversification of liquid fossil fuels. The scientific community has moved toward developing sustainable, economically feasible, and easily processed alternative fuel. Biodiesel is derived from edible or non-edible vegetable oils/animal fats by transesterification reaction with short chain such as C1/C2 alcohols in the presence of acid or base catalyst. The base-catalyzed transesterification shows faster kinetics than its acid counterpart. The commonly used basic catalysts are sodium and potassium hydroxides as well as methoxide salts. These catalysts are superior in terms of reaction catalysis at mild reaction conditions such as low temperature and atmospheric pressure, high yield in shorter time, and are economically viable. Consequently, these are being used in commercial scale biodiesel production. Recently, heterogeneous base catalysis has fascinated the scientists for biodiesel production. The reason is that the recovery and reusability of catalysts is possible in the case of heterogeneous catalysts. Biodiesel has several reasons for which it can substitute diesel fuel. Biodiesel is ecofriendly, supports agricultural economy and rural development, is biodegradable, carbon neutral, and nontoxic in nature. Biodiesel exhibits several interesting typical features such as high flash point, high lubricity, higher cetane number, and low viscosity. However, for commercialization of biodiesel, its higher production cost is a major hurdle. The cost of selected feedstocks is the constitutive factor which is responsible for economic viability of biodiesel. Raw materials cost accounts for 70–95% of total production cost of biodiesel. India is one of the largest importers of edible oils in the world; its imports contribute 55% of the total domestic edible oil consumption, thus identification of new feedstock (non-edible in nature) for commercial biodiesel production is very crucial. Indian Government supported non-edible feedstock for the development of biodiesel in renewable energy sector since 2005 and started with national biodiesel mission. On the basis of complexity of direct and indirect effects of plantation of energy crops on land and water use along with biodiversity, identification of forest based plants could be potential feedstock for biodiesel synthesis for a country like India with its demographic, socioeconomic, human development, and governance challenges. Thus scrutiny of forest-based plants as potential feedstock for biodiesel synthesis could be promising option rather than plantation of new oil seed crops. Relatively very less literature is reported on utilization of Chicken fat oil for biodiesel production. The other relatively less available feedstocks used in this work are waste vegetable oil. Chicken fat is a waste product of butchers shop, poultry, hotels, restaurant, and food industries posing disposal problems. If it thrown away in water stream, free fatty acid (FFA) present in oil pollute the natural sources of water with drainage problems. The chicken fat is a low-cost waste product of slaughter houses. It is extracted from chicken feathers, blood, offal, and trims after rendering process, which are

usually thrown away causing environmental pollution. In addition to be a possible feedstock, use of CFO as feedstock for biodiesel production diminishes its disposal problems and assures the supply of biodiesel. Each broiler chicken gives approximately 100–110 g of non-edible fat with high FFA value. The favourable price of waste materials, CFO is 2.5–3.5 times lower than that of the refined vegetable oil [1]. Utilization of CFO for biodiesel production will help to reduce the problem of waste management and can be economically viable source for energy production. Almeida et al [2] successfully synthesized ethyl biodiesel from chicken fat by using reaction parameters 10% V2O5/ RHA catalyst at 2008C with 1:10 oil-to-ethanol molar ratio for 4 hour reaction time, exhibiting 91% conversion to biodiesel. Gurusala et al. [3] had produced chicken fat methyl ester from high acid value (26.58 mg of KOH) chicken fat by pre-treatment esterification with ferric sulphate acid catalyst followed
by base-catalyzed transesterification process. They measured fuel properties of synthesized CFOME which met ASTM standards. Guru et al. [4] evaluated the effect of Mg based additives in chicken fat biodiesel on engine performance and exhaust emissions on DI engine. Marulanda et al [5] also synthesized CFME under supercritical conditions at 300–4008C temperature. Mata et al. [6] concluded that higher viscosity and density of chicken fat biodiesel does not allow using 100% biodiesel in diesel engine, specifically in lower temperature climates. Instead of using pure biodiesel directly to diesel engine, it can be applied in blends to improve kinematic viscosity, calorific value, and cold filter plugging point [7]. The objective of this research work was synthesis of biodiesel by the transesterification of selected feedstock with methanol using Sulphuric acid (as a homogenous catalyst). This study evaluated important fuel quality peculiarities such as density, viscosity, flash point, fire point, cetane number, calorific value, cloud point, and pour point as per ASTM 6751 and EN 14412 standard specifications.

II. MATERIALS AND METHOD

A. Chemicals

The feedstocks used in this study were CFO. Chicken fat oil was produced at Indian Biodiesel Corporation, Baramati, Maharashtra, India. CFO was collected from local slaughter houses. The chemicals methanol (CH_3OH), sulphuric acid (H_2SO_4), Sodium hydroxide (NaOH) were of analytical grade and were purchased from Merck limited, Mumbai. The double distilled water was prepared by in laboratory.

B. Instrumentation

The etherification and transesterification reactions were performed in four necked round-bottom flask (RBF) equipped with 110 degree Celsius mercury thermometer and mechanical stirrer (Bio lab BL22D). Temperature was regulated by a heating mental. A borosilicate condenser was attached to RBF for condensation of unreacted evaporated methanol from reaction mixture.

C. Oil Extraction

The chicken fat was heated in high-temperature bath. A specific amount of edible oil (having known composition of fatty acid amount) sodium salt was added in it. The oil was extracted at 220 degree Celsius for 6 hour. After extraction, mixture was allowed to cool at room temperature and filtered for separation of solid parts from the oil [6].

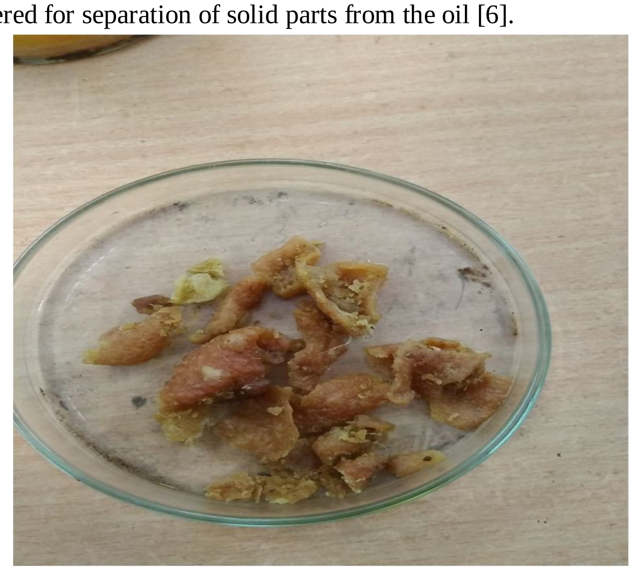

Fig. 1 Chicken Fat

Fig. 2 Chicken Fat oil

D. Experimental Details

The feedstock containing higher FFA amount cannot be directly transesterified because of soap formation between base catalyst and FFA. CFO has higher acid value of 22 mg KOH/g. To reduce the FFA,CFO is subjected to esterification. Esterification is a chemical reaction typically between an alcohol (e.g., methanol) and an acid (e.g., FFA) in the presence of catalyst; respective esters are formed as reaction product. It was investigated that liquid acid-catalyzed systems, sulfuric acid, and hydrochloric acids are more efficient when acid value of oil is high [8]. FFA composition and molecular mass of every feedstocks decide the concentration of sulphuric acid used. To perform esterification of CFO, 1000 mL oil was poured in RBF equipped with heating mental, mechanical stirrer, thermometer, and condenser. The temperature of CFO was raised to 35–408C. After heating, approximately 0.7% H2SO4 and methanol (in 6:1 molar ratio to oil) was added in preheated oil. The reaction mixture was refluxed for 60 minutes at 600–650 rpm stirring rate at 60658C. Reaction mixture was transferred into a separating funnel for at least 3 hour to separate esterified oil from solid impurities. The upper separated layer of esterified oil was dried in hot-air oven for 2 h at 1108C. The acid value of CFO was reduced to 4.7 mg KOH/g after esterification. After completion of esterification, alkaline transesterification reaction was carried to convert lower acid valued CFO into their esteemed methyl esters (biodiesel). A homogenous strong base NaOH was used as catalyst. The transesterification reaction was performed in the same reactor with varying reaction parameters, that is, methanol-to-oil molar ratio from 4:1 to 11:1, catalyst 0.4–1.4 wt %, temperature 45–90 degree Celsius, and time from 30 to 100 min. Each reaction variable was optimized separately with each feedstock. The reaction progress was observed by thin layer chromatography (TLC) in 10 min intervals. At completion of reaction, methanol was evaporated by refluxing above reaction mixture at 75-65 degree Celsius and the residual mixture was poured in settling tank for 8–10 hour. Glycerin (by product) got settled at the bottom of the tank due to higher density, which was separated from upper biodiesel layer. Biodiesel was washed with hot distilled water and dried in hot-air oven at 1058C for 2 hour. The trace of water was removed by heating the product. At last pure biodiesel was obtained. i.e. B100, then different blends were prepared by heating conventional diesel and biodiesel at 45 degree Celsius and mixing them in different proportions. Thus we obtained following blends
B20, B25, B30, B35, B40, B50.

Fig. 3 Blends

III. RESULTS

The biodiesel and its blends were successfully prepared as per ASTM 6751 specifications and its properties were found to be as follows

Sr No.	Test Description	Ref. Std. ASTM 6571	Reference		Diesel	Chicken fat oil biodiesel belnds					
			Unit	Limit	B00	B20	B25	B30	B35	B40	B50
1	Density	D1448	gm/cc	0.8-0.9	0.83	0.835	0.836	0.837	0.838	0.841	0.844
2	Calorific Value	D6751	MJ/kg	34-45	42.5	42.08	41.9	41.77	41.52	41.38	41.22
3	Centene No.	D613	-	41-55	49	49.7	49.9	49.99	50.22	50.49	50.69
4	Viscosity	D445	mm^2/s	3-6	2.7	-	-	3.2	-	-	-
5	Moisture	D2709	%	0.05%	NA	NA	NA	NA	NA	NA	NA
6	Flash point	D93	℃	-	64	77	83	94	109	117	122
7	Fire Point	D93	℃	-	71	-	-	107	-	-	-
8	Cloud Point	D2500	℃	-	-4	-	-	7.5	-	-	-
9	Pour Point	D2500	℃	-	-9	-	-	2.5	-	-	-
10	Ash	D	%	-	0.05	-	-	0.05	-	-	-

Table. 1 Biodisel property table

IV. CONCLUSIONS

CFME showed all fuel quality parameters in limit, as compared to ASTM 6751 specifications. The CFO methyl esters were also synthesized using 8:1 molar ration of alcohol to oil, 1 wt % of NaOH Considering the cost of feedstock for biodiesel production, this oil is economically viable and the synthesized biodiesels showed acceptable fuel quality parameters specified by ASTM standard 6751 b07 specification and EU 14214 specifications. Considering the recycling and conversion of waste material into value-added products, chicken fat raw material can be a potential source for biodiesel production which will simultaneously give local, regional, and national benefits in future.

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