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Application of waste chicken fat in base catalyzed (potassium hydroxide) biodiesel production

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ABSTRACT – The objective of this research was to analyze the effect of temperature, catalyst ratio and methanol ratio on biodiesel yield from waste chicken fat. The optimum yield were 95.4% with 0.006 w/w catalyst and 0.3 w/w alcohol at 50°C. The product density was 873.4 kg/m^3, the iodine value, 117 g I/100g and the acid value, 0.561 mg KOH/g. The compositions of fatty acids were 0.22% of methyl laurate, 19.98% of methyl palmitate, 41.08% of methyl stearate and 0.17% of methyl linoleate. Consequently, the biodiesel obtained under these conditions had characteristics very similar to those described in the ASTM standards.

1. INTRODUCTION

Nowadays, the alternative lipids waste residues as waste frying cooking oil and inedible waste animal fats have also majoring considerable attention from green fuel sector. Consequently, a recycled program, which has to reuse residues in order to take advantage of these low cost and low quality resources, and hence successfully integrate the sustainable energy supply and waste management in food processing facilities. The waste chicken fat (WCFs) have a great potential as feedstocks for biofuel industry, because they are not commodities, having a lower market value.

Darunde [1] claimed that the saturated fatty acids from WCF are the source of high CN and the values over 60 are common. Soybean oil based biodiesel usually has a CN about 48-52 and petroleum-based diesel fuel is usually between 40 and 44. As a result, the WCF with a higher CN, indicating a shorter ignition delay time, more complete combustion of the fuel and hence should improve the fuel efficiency.

Furthermore, the WCF biodiesel could bring a number of environmental, economic and social advantages. Biodiesel is free from sulfur, hence less sulfate emissions, and reduced particulate matters (PM) in the engine exhaust. Due to the near absence of sulfur in the WCF, it helps reduce the problem of acid rain caused by emission of pollutant from fuels burning. The lack of aromatic hydrocarbon (benzene, toluene etc.) in biodiesel reduces unregulated emissions as well as ketone, benzene etc. Breathing particulate matter has been found to be hazardous for human health, especially in terms of respiratory system problems. PM consists of elemental carbon (~31%), sulfates and moisture (~14%), unburnt fuel (~7%), unburnt lubricating oil (~40%) and potential remaining metals and others substances [2].

2. MATERIALS AND METHODOLOGY

2.1 *Transesterification reaction and separation process*

The chicken fat was heated up till desired temperature. The temperatures are 50°C, 60°C and 70°C. As the oil has reached the desired temperature, the mixture of potassium hydroxide and methanol was poured into the beaker containing the waste chicken oil. The speed of the stirring was kept at 200 rpm throughout the experiment. The reaction time is kept constant for one hour. The time allocated for the product to separate was six hours. The top product is biodiesel while the bottom product in the separator funnel is glycerol. The glycerol is removed from the separator funnel and discarded.

2.2 *Analysis of biodiesel*

In order to determine the characteristic of the biodiesel sample was analyzed by using four different analyses such as acid value test, iodine value test, density test and Fatty Acid Methyl Ester (FAME) analysis.

3. FINDINGS AND DISCUSION

3.1 *Effect of temperature to biodiesel*

The rate of reaction is influenced by the reaction temperature as per kinetics of reaction. Generally the reaction is conducted close to the boiling point of the methanol at the atmospheric pressure [3]. The maximum yield of esters was observed at temperature ranging from 50 ± 5°C. Figure 1 shows the highest percentage of yield at 50°C.

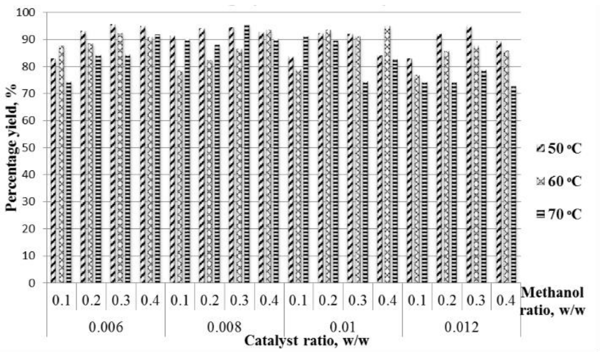

Figure 1 Effect of temperature, catalyst ratio and methanol ratio on biodiesel yield.

3.2 Effect of methanol ratio to biodiesel

Based on Figure 1, the optimum alcohol ratio for transesterification is at 0.3 w/w as it yields the highest biodiesel up to 95.4%. This situation shown concluded that as when the methanol ratio is high, the biodiesel yield decreases. According to Komintarachat and Chuepeng [3], at higher methanol amount, the free fatty acid (FFA) conversion increased but the yield decreased. This is due to the transesterification reaction which is reversible as the additional methanol accelerates considerably an adjustment of the new equilibrium. A high amount of methanol interferes the separation of glycerol due to an increase in solubility while the glycerol remaining in the solution drives the reaction equilibrium back, resulting in the lower yield of biodiesel.

3.3 Effect of catalyst ratio to biodiesel

A catalyst functions to accelerate the reaction rates. Catalyst is an important factor in transesterification of waste chicken fat into biodiesel. The catalysts that are commonly used are KOH and sodium hydroxide (NaOH). According to the obtained data, it can be seen that the more catalyst being used, the more yield is obtained but the reaction decreases. This is because, if too much catalyst is being used, the reaction might change to saponification reaction that produces soap. Soap is the undesired product. Therefore it can be said that the optimum catalyst ratio that yield the most biodiesel is 0.01 w/w with the biodiesel conversion of 95.4%. The same trend was discovered by Komintarachat and Chuepeng [3], which mentioned that an increasing amount of catalyst will caused the slurry which is a mixture of catalyst to reactant to occur problem in mixing thus a demand of higher power is required for adequate stirring.

3.4 FAME analysis

The composition of biodiesel was determined using gas chromatography (GC) with retention time was 20 minutes. There are four fatty acids in the biodiesel that was able to be identified which are methyl laurate, methyl palmitate, and methyl stearate and methyl linoleate. The percentage composition for methyl laurate is 0.22%, methyl palmitate is 19.98%, methyl stearate is 41.08% and methyl linoleate is 0.17% as shown in Table 1.

Table 1 Experimental value of biodiesel with the standard value.

Characteristic	Experimental Value	EN 14214	ASTM standard
Density, kg/m^3	873.4	860-900	860-900
Acid Value, mgKOH/g	0.561	< 0.5	< 0.8
Iodine Value g I/100g	117.0	< 120	< 120

4. CONCLUSION

Transesterification reaction involves WCF to react with alcohol with the presence of base catalyst (KOH) to yield biodiesel and glycerol. The optimum parameters for producing biodiesel in this project is at 50°C with the ratio of catalyst to oil 0.006 w/w and methanol to oil ratio of 0.3 w/w. The yield obtained at this parameter is 47.7 g of biodiesel and the percentage of yield is 95.4%. The organic compounds in the biodiesel produced consist 0.22% methyl laurate, 19.98% methyl palmitate, 41.08% methyl stearate and 0.17% methyl linoleate. The iodine value of the biodiesel produced is 117 gI/100g while the density obtained is 873.4 kg/m^3 and the acid value of 0.561 mgKOH/g that met EN 14214 and ASTM D6751 biodiesel specifications.

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