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Review of Various Reaction Parameters and Other Factors Affecting on Production of Chicken Fat Based Biodiesel

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Abstract:
This paper represents review of various reaction parameters and other factors which affects the production of chicken fat biodiesel. These are following reaction parameters which affect the production of chicken fat based biodiesel are temperature, molar ratio, reaction time, catalyst concentrations, physical properties and composition, Purity of Reactants, Mixing Intensity ,type of catalyst used and other factors affects which are Free Fatty Acid (FFA) and Moisture level Contains in feedstock.

Key words: Biodiesel, chicken fat, alternative fuel, reaction parameters, catalyst.

1.1Effect of temperature:

To study the effect of temperature on biodiesel yield, the molar ratio of methanol to oil was fixed as 6:1 and the catalyst concentration as 1%. The reaction time is also fixed for 60 minute. The result obtained was displayed in figure 1. A maximum yield of biodiesel was reached at 50°C. An increased temperature up to 70 °C resulted in lower yield. Using similar catalyst but different feedstock's [2]. Obtained opposite results in which an increase temperature up to 70°C led to maximum yield of biodiesel. Further increase in temperature lowered the biodiesel yield due to the evaporation of methanol. This result was also observed by other researchers.

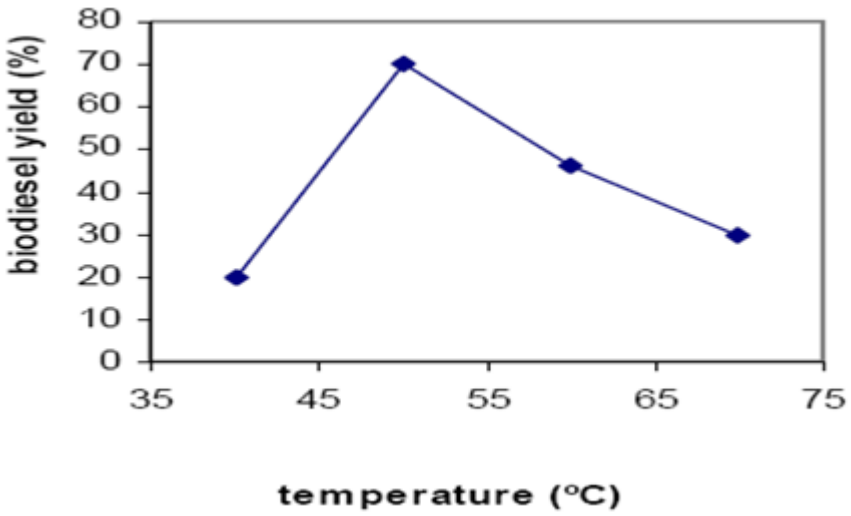

Fig.1 Effect of temperature on the biodiesel production.
Reaction condition: molar ratio of methanol to oil 6:1,
Catalyst concentration 1%, Reaction time 60 minute

Other researchers [3] also studied the transesterification of refined oil using methanol with the molar ratio of alcohol to oil (6:1) and NaOH (1% w/w of oil) in three different temperatures. After 0.1 h, ester yields were 94, 87 and 64% for 60˚, 45˚ and 32°C, respectively. After 1 h of reaction, the ester formation was identical for 60˚ and 45°C and was slightly lower for 32°C. The maximum yield of esters were obtained in the temperatures ranging from 60–80°C at a molar ratio of 6:1 and further increase in the temperature decreases the conversion.[2]

1.2 Effect of molar ratio:

The effect of molar ratio methanol to oil was shown in figure 2. The temperature, reaction time and catalyst concentration was fixed as 50°C, 60 minute and 1% respectively. As the molar ratio of methanol to oil increased from 3:1 to 6:1, the production yield also increased. Further increase resulted in lower yield. The optimum molar ratio of methanol to oil was determined as 6:1 for maximum yield (75.4%) of biodiesel fuel from chicken fat using CaO catalysts. Therefore, we concluded that to elevate the

biodiesel yield and excess methanol feed was effective to a certain extent. The molar ratio of alcohol to triglyceride is the most important variable affecting the biodiesel yield. The stoichiometric ratio for the transesterification requires three moles of alcohol and one mole of triglyceride to yield three moles of biodiesel and one mole of glycerol. However, transesterification is an equilibrium reaction in which a large excess of alcohol is required to drive the reaction to the forward direction. However, the high molar ratio of alcohol to vegetable oil interferes with the separation of glycerin because of the increase in solubility. When glycerin remains in solution, it helps to drive the equilibrium back to the left, lowering the yield of esters [4].

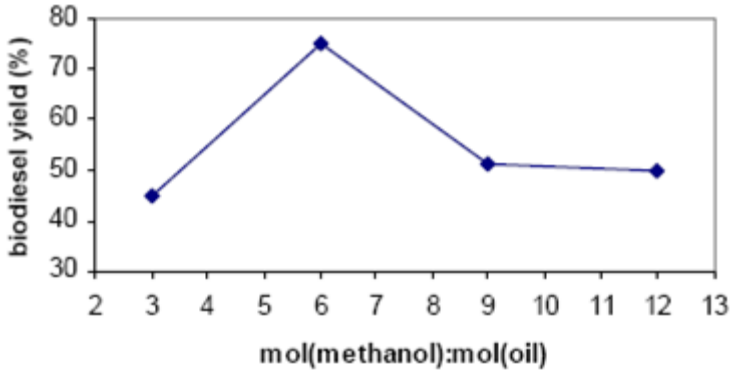

Fig.2.Effect of methanol to oil molar ratios on the biodiesel production. Reaction condition: temperature of 50˚c, catalyst concentration 1%, Reaction time: 60minute.

1.3 Effect of catalyst concentrations:

A catalyst functions to accelerate the reaction rates. For transesterification reaction, an increasing amount of heterogeneous catalyst caused the slurry (mixture of catalyst to reactant) too viscous giving rise to a problem of mixing and a demand of higher power consumption for adequate stirring. On the other hand, when the catalyst loading amount was not enough, maximum production yield could not be reached. To avoid this kind of problem, an optimum amount of catalyst concentration had to be investigated. The effect of catalyst concentration on the biodiesel yields was shown in figure 3.

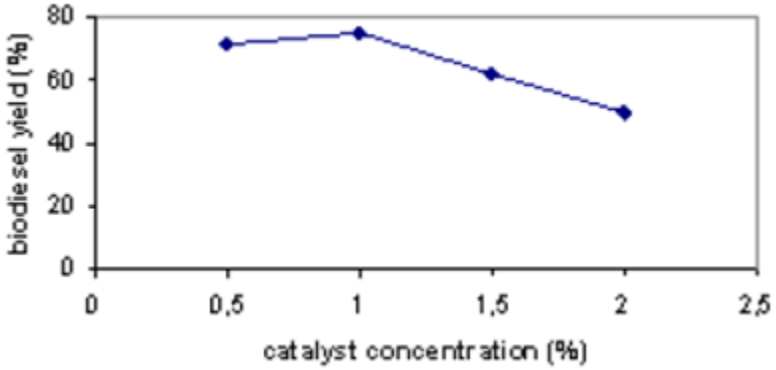

Fig.3.Effect of catalyst concentration on the biodiesel Production. Reaction condition: temperature of 50˚c, molar ratio of methanol to Oil ratio 6:1, reaction time of 90minute.

Other variables such as reaction time, temperature and molar ratio of methanol to oil were kept constant. The maximum biodiesel yield was obtained with 1% catalyst concentration. The figure indicated that the biodiesel yield decreased with different catalyst concentration. Methanolysis of soybean oil with potassium hydroxide catalyst 1% (w/w of oil) also gave the best yields and viscosities of the esters .alkaline metal oxides are the most active catalysts form ethanolysis since they give very high yield (98%) in shorter reaction times (30 min), even if they are applied at low molar concentrations (0.5 mol%). [6][10][11]The acid catalysts also give very high yield of alkyl esters at high temperatures (around 100°C) but the reactions are slow and take around 3 h to reach the same conversion., acid catalysts generally require 0.5–1 mol% catalyst concentration to achieve around 99% conversion.[1].

1.4. Effect of Reaction time:

The figure 4 presented the biodiesel yield versus reaction time. It showed that there was a great jump from 30 minute to 60 minute which indicated that the reaction was very rapid in the beginning. The Biodiesel yields then increased slowly and remained nearly constant thereafter.[7] transesterified peanut, cottonseed, sunflower and soybean oil with methanol-oil molar ratio of 6:1 and 0.5% (w/w of oil) sodium methoxide catalyst at 60°C.Around 80% yield was observed after 1 min for soybean and sunflower oils. After 1 h, the conversion was almost the same for all the four oils (93–98%). studied the effect of reaction time on transesterification of beef tallow with methanol and the reaction was found to be very slow during the first minute due to mixing and dispersion of methanol into beef tallow. For the first 5 min, the reaction proceeded very fast. The production of beef tallow methyl esters reached the maximum value at about 15 min.

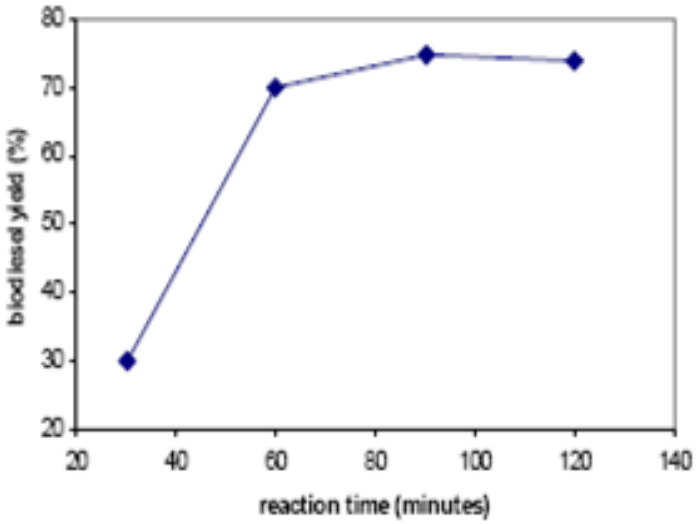

Fig.4. Effect of reaction time on the biodiesel production.
Reaction condition: temperature of 50˚c,
Molar ratio of methanol to oil 6:1, catalyst concentration 1%

1.5. Effect of Physical Properties and composition:

The fatty acid composition of as-synthesized biodiesel was determined by GC analysis and the results were shown in table 1. The oleic acid is the dominant component of biodiesel synthesized from chicken fat, followed by palmitic acid. The other fatty acid contents are lower than 10 % by wt.

Table 1. Composition of as-Synthesized Fatty Acid Methyl Esters (FAME).

Sr. No.	Fatty Acid Methyl Ester	Percentage (% By Wt.)
1	Miristic	0.59
2	Stearic	0.89
3	Linoleic	7.33
4	Palmitic	24.04
5	Oleic	60.98
6	Palmitoleic	4.42

The characteristic as-synthesized biodiesel was determined for six important properties of biodiesel fuel and compared with Indonesian national standard for biodiesel. The results are displayed in table 2 which clearly show within limit of Indonesian standard for biodiesel

TABLE II. THE CHARACTERISTICS OF AS-SYNTHESIZED BIODJESEL

Sr. No.	Characteristic	Unit	Biodiesel	Standard Range
1	Density	Kg/m3	879	850 to 890
2	Kinematic Viscosity	Mm2/s	4.1	2. 3 to 6. 0
3	Water Content	% vol.	178	Min. 100
4	Cetane Number	-	73.73	Min. 51
5	Iodium number	gr Iod/ 100 gr	29.36	Max. 115
6	Acid Number	Mg KOH/gr	0. 58	Max. 0.8

1.6 Effect of Mixing Intensity:
To achieve perfect contact between the reagent and oil during transesterification ,they were mixed together .It has been observed that during the transesterification reaction ,the reactants initially form a two phase liquid system .The mixing effect has been found to play a significant role in the slow rate of reaction .As phase separation ceases ,mixing on the kinetics of the transesterification process forms the basis for process scale up and design .The mixture is stirred
At about 650 to 700 rpm for one hour .It was found that phase separation occurs after 3-4 minutes stirring but maximum ester yield was reached after 30 minutes of stirring.[4][5]

1.7 Effect of Purity of Reactants:
Impurity in oil affect the conversion level considerably .It is reported that about 65-84 % conversion into esters using crude vegetable oils have been obtained as compared to 94-97 %
Yields refined oil under the same reaction conditions. The free fatty acids in the crude oils have been found to interface with the catalyst .This problem can be solved if the reaction is carried out under high temperature and pressure conditions. [4][5].

1.8 Effect of Catalyst Type:
Considerable research has been done on biodiesel made from virgin vegetable oils (e.g., peanut oil, palm oil, soybean oil, sunflower oil) using homogeneous alkali catalysts. The majority of biodiesel today is produced by alkali-catalyzed (e.g., NaOH, KOH) transesterification with methanol, with results in a relatively short reaction time. However the vegetable oil and alcohol must be substantially anhydrous and have low free fatty acid content, because the presence of water or free fatty acid or both promotes soap formation. Soap formed lowers the yield of esters and renders the downstream separation of the products difficult, requiring additional processing .Another drawbacks arise from the use homogeneous base catalyst are difficulty in purification of byproduct glycerol and the need of wastewater treatment. To alleviate these problems, use of a solid base catalyst was proposed. Solid base catalysts have many advantages, such as mild reaction condition, easy separation, and high activity and less contaminant. In this investigation, waste chicken fats as feedstock for biodiesel production have relatively high amount of free fatty acids and water content results in the production of soap in the presence of alkali catalyst. Thus, additional steps to remove any water and either the free fatty acids or soap from reaction mixture are required. the use of solid base catalyst for the production of biodiesel from fats produced from waste chicken skins and determined suitable condition. Heterogeneous catalyst is best suited due to its cheap price, minor toxicity, high availability and high basic strength [1].

1.9 Effect of Free Fatty Acid (FFA) Contains:
The problem with processing waste chicken fat oils is that they usually contain large amounts of free fatty acids that cannot be converted to biodiesel using an alkaline catalyst due to formation of fatty acid salts (soap). The soaps can prevent separation of

the biodiesel from the glycerin fraction. An alternative method is to use acid catalysts, which are able to esterify free fatty acids investigated the relationship between FFA level and triglyceride transesterification during acid catalyzed biodiesel production. To prepare esters with a high yield using alkaline catalysis, it is necessary for the feedstock to have a low FFA value. The FFA value is a measure of the number of acidic functional groups in a sample and is measured in terms of the quantity of potassium hydroxide required to neutralize the sample. [11]

1.10 Effect of Moisture level:

The moisture levels of the collected waste chicken fats vary widely, being as high as 18%. Therefore, it is not possible to convert these oils to biodiesel by using a single process. One drawback of biodiesel is that there is an inverse relationship between biodiesel's oxidative stability and its cold flow properties. Saturated compounds are less prone to oxidation than unsaturated compounds but they raise the cloud point of the fuel. The reaction of FFAs with alcohol produces ester, but also water that inhibits the of the transesterification glycerides. This is due to the effect of the water produced when the FFAs react with the alcohol to form esters. The coincidence of the lines indicates that water formation is the primary mechanism limiting the completion of the acid catalyzed esterification reaction with FFAs. [11]

Conclusion

To get the maximum production of chicken fat base biodiesel reaction parameters are as follows, at 50˚c gets maximum production keeping other parameters constant. The optimum molar ratio of methanol to oil was determined as 6:1 for maximum yield (75.4%) of biodiesel fuel from chicken fat using heterogeneous catalysts. The maximum biodiesel production was obtained with 1% catalyst concentration. It showed that there was a great jump from 30 minute to 60 minute which indicated that the reaction was very rapid in the beginning, the biodiesel yields then increased slowly and remained nearly constant thereafter. The mixing effect has been found to play a significant role in the slow rate of reaction, It was found that phase separation occurs after 3-4 minutes stirring but maximum ester yield was reached after 30 minutes of stirring. Heterogeneous catalyst is best suited due to its cheap price, minor toxicity, high availability and high basic strength. Due to the high level of FFA in the waste chicken fats, transesterification cannot be applied directly. It is necessary to reduce the FFA level of the oil by using an acid catalyst process. With traditional alkali catalyzed processes, free fatty acids escape conversion into esters by reacting with the catalyst to form soaps with acid catalyzed processes. The moisture levels of the collected waste chicken fats vary widely, being as high as 18%, therefore, it is not possible to convert these oils to biodiesel by using a single process.

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