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Effect of Temperature on Viscosity of Some Plant Oils for Producing Biodiesel

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Abstract : *Globally one of the major difficulties face producers of biodiesel fuels from crude vegetable oils as alternative fuel in diesel engines is their relatively high viscosity. Increasing the temperature of crude plant oils, offers a simple and effective means of controlling and lowering the viscosity of vegetable oils. This study was conducted to assess the impact of temperature on viscosity of Jatropha, Palm Kernel and Coconut oils as raw materials for producing biodiesel. Method of Association of Official Analytical Chemistry International (AOAC), Indonesian National Standard (SNI) were used to analyze the viscosity of Jatropha, Palm Kernel and Coconut oils. ANOVA was performed to evaluate the different between data by SPSS Version 16 and Microsoft Excel (2013). Viscosity of oils was checked at different temperatures (25, 30, 35, 40oC).These results showed significant differences ($P<0.05$) in oils viscosities value between used temperatures, In these results Viscosity 25^oC (mm2/s) of Jatropha, Palm Kernel and Coconut oils 31.00±0.00, 30.00±1.00, 42.00±0.00, Viscosity 30^oC (mm2/s) 29.00±0.00, 26.50±0.70, 31.50±.70711, Viscosity 35^oC (mm2/s) 23.00±1.41, 26.00±1.41, 29.00±0.00, and Viscosity 40^oC (mm2/s) 21.33±2.08, 23.33±0.57, 20.50±0.70 respectively. Viscosity of Coconut oils 42.00±0.00 at 25^oC (mm2/s) showed significant difference with the Indonesian standards SNI of crude vegetable oils for biodiesel, and viscosity of Jatropha and Palm Kernel 31.00±0.00, 30.00±1.00 and Jatropha, Palm Kernel, Coconut oils at other temperatures not significant difference with (SNI). These results showed that the temperature has high significant effect on reducing viscosity of vegetables oils. Oils temperatures at 40^oC has better viscosity, therefore is suitable for producing biodiesel.*

Keywords*: Jatropha oil, Palm kernel oil, Coconut oil, temperature, Viscosity*

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I. Introduction

Biodiesel are alternative fuel made from renewable Biological sources such as vegetable oils both (Edible and non-edible oils) and animal fats (Raja et al., 2011),(Avhad and Marchett, 2015), (Ma and Hanna, 1999). Biodiesel are renewable fuel made from vegetable oils and animal fats, which is recyclable. The suitable method of production biodiesel has been alkaline trans-esterification of the oil or fats with alcohol (Apita and temu, 2013). Biodiesel produced from different triglyide sources is an alternative fuel to petro-diesel. the American Society for Testing and Materials (ASTM) mentioned that biodiesel as mono-alkyl esters produced from various lipid feedstocks including vegetable oils, animal fats, etc. However, has verified that the direct usage of vegetable and animal oils as diesel fuel is impractical due to their large molecular mass, low volatility, and high viscosity, which reduce the performance of the engine and raise other problems (Venkatesan et al., 2012). To overcome these probelms and allow its application as a fuel, several methods have been implemented such as blending with petro-diesel, microemulsification, pyrolysis and trans esterification(Charusiri and Vitidsant, 2017), (Avhad and Marchetti, 2015), (Zahan and Kano, 2018).Oil viscosity is usually measured and defined in two ways, either based on its absolute viscosity or its kinematic viscosity. The absolute viscosity of the oil is its resistance to flow and shear due to internal friction and is measured in SI units in Pa. By contrast, the kinematic viscosity of the oil is its resistance to flow and shear due to gravity and is measured in SI units of m2 / s. The kinematic viscosity of the oil can be obtained by dividing the absolute viscosity of the oil with its corresponding density (Singh and Heldman, 2001).It has been well proven that temperature has a strong effect on the viscosity of liquids with generally lower viscosity as the temperature increases(Rao, 1999), (Rao, 2007).Globally one of the major difficulties face producers of biodiesel fuels from crude vegetable oils as alternative fuel in diesel engines is their relatively high viscosity.Increasing the temperature of crude plant oils, offers a simple and effective means of controlling and lowering the viscosity of vegetable oils(Tangsathitkulcha et al., 2004).This present study aimed to identification the influence of temperature on reducing viscosity of vegetable oils as raw materials for producing biodiesel.

II. Materials And Methods

This study was conducted on March to may 2016 inLaboratories of postharvest, Pilot palnt and Chemistry at Padjadjaran University – Indonesia.

Samples preparing

Samples were collected from different provinces are West Java (Palm Kernel and Coconut fruits), Sumatra island (Jatropha seeds) – Indonesia.

Oil Extraction

The Oils were extracted according to methods of (Orhevba et al., 2013), and (Mandal and Lee, 2013). The oil was extracted using cold press extraction with small scale expeller (temperature 40 – 60^{o}C). Oils were filtered using (plastik filter and centrifuge).

Viscosity analysis of extracted oils

The viscosity of oil was checked by digital viscometer using spindle L1, rpm 100 at different temperature degrees (25, 30, 35, And 40^{o}C) according to method of (Siddique et al., 2010), (Tangsathitkulcha et al., 2004).

Statistical Analysis

The analysis were carried out in triplicates. Descriptive explanatory method will be employed to discuss the results. ANOVA was be performed to evaluate the difference between data by SPSS version 16.

III. Results And Discussion

Compositions of Jatropha, Palm kernel seeds and Coconut fruit

Proximate composition of Jatropha, palm kernel and coconut seeds showed in Table1. The moisture mean value of Jatropha was 15.91 percent, palm kernel was 7.69 percent and coconut was 1.02 percent. These results showed that the moisture of Jatropha seed is higher than other group, and moisture of coconut oil is lower than other group. This is different due to process drying of Jatropha and palm seeds are not good because environment factor as lower temperature and high air humidity. The moisture content of palm oil agree with the results of Akpanabiatuet al (2001), and moisture of palm kernel and coconut seeds are disagree with Nzikou, et al., 2009, causes to soil, genotype, environment factors as temperature and air humidity.The fats content of Jatropha was 19.84 percent, palm kernel was 49.81 percentand coconut was 72.40 percent seeds. These results showed that fats content of coconut is higher than palm kernel and Jatropha seeds. This is different may due to genotype and temperature. Fat content of palm agree with the results of Akpanabiatuet al., 2001, and disagree with Ugbogu, et a.l, 2014, causes to climate, optical length of day and time harvest.The ash content of Jatropha was 4.22 percent, palam kernel was 1.89 percent and coconut was 2.16 percent. From these results obtained the ash content of Jatropha is higher than other group, and ash content of palm kernel is lower than Jatropha and coconut seeds. This is different may due to climate, structure seeds and ratio of metallic elements. Ash content of Jatropha is agree with results of Nzikou, et al., 2009, who reported the 4.2 percent range for crude ash, and Ugbogu, et al., 2014, them reported 4.9 percent range for crude ash.The protein content of Jatropha was 19.21percent, palm kernel was 11.00percent and coconut was 6.44percent. These results showed that protein content of Jatropha is higher than palm and coconut seeds, causes genotype, temperature and soil. Protein content of palm kernel is disagree with Atasie and Akinhanmi, 2009.This different may due to climate, soil, and temperature.The carbohydrate content of Jatropha was 40.82percent, palm kernel was 29.61percent and coconut was 21.35percent seeds. From these results showed that carbohydrates content of Jatropha is higher than other group, and coconut carbohydrates content is lower than other group. The carbohydrates content disagree with Atasie and Akinhanmi (2009). This is different may due to environment factors as varity of seeds, temperature, soil, air humidity, and genotype. From these result that showed above, the coconut has been higher fat contents, which is lead to increasing the viscosity of its oil, because the viscosity has relationship with fat and protein precent that seeds contains.

Table 1: Compositions of Jatropha, palm and coconut Seeds

Contents (%)	Jatropha	Palm	Coconut
Moisture	15.91	7.69	1.11
Ash	4.22	1.89	2.16
Fats	19.84	49.81	73.36
Protein	19.21	11.00	1.29
Carbohydrate	40.82	29.61	21.35

Viscosity of Jatropha, Palm kernel, and Coconut oils

From the below Table2and Fig1, these results showed significant different (P<0.05)betweenoils viscosity values. Viscosity of coconut oil at 25^{o}C(mm^{2}/s) was 42.00±.000, Palm kernel oil was 30.00±1.000, and Jatropha oil was 31.00±1.00. From these result the viscosity of coconut oil is higher than viscosity of Jatropha and Palm kernel oils, and viscosity of palm kernel is lowerest than other oils. These results disagree with (Vedand Padam, 2013), (Ibrahim et al., 2016), and showed significant difference with the Indonesian National standards(SNI, 2015) of crude vegetable oils for biodiesel.The viscosity ofJatropha, Palm kernel and coconut oils at 30^{o}C (mm2/s) was29.00±0.00, 26.50±0.70, 31.50±0.70711respectively. From these results showed that the viscosity of coconut oil is higher than other groups, and viscosity of palm kernel is lower than Jatropha and Coconut oils. These results agree with (Suganyaet al., 2013). The Viscosity of Jatropha, Palm kernel, and Coconut oils at 35^{o}C (mm2/s) was 23.00±1.41, 26.00±1.41, 29.00±0.00respectively. And Viscosity of Jatropha, Palm kernel, and Coconut oils at 40^{o}C (mm2/s) was 21.33±2.08, 23.33±0.57, 20.50±0.70 respectively.These results showed no significant difierence (P<0.05)between oils viscosity and Indonesian National Standard SNI, (2015). And agree with Olashe et al.,(2015) they reported that the sensitivity analysis showed that Jatropha oil has highest density and viscosity values at 30^{o}C and lowest values at 100^{o}C, Charusiri, W., &Vitidsant,(2017),the temperature has significant effect on physicochemical properties of biofuel yield and and yield of diesel, Pramanik, (2003),that mentioned the heat contributes to reducing the viscosity and density of vegetable oils, as jatropha oil. moreover, the blending oil with diesel is one of other methods capable to reduce viscosity of vegetable oils. The viscosity of jatropha oil was decreased based on increasing the diesel content in the blend.

Table2: ViscosityofJatropha, palm kernel, and coconut oils

Parameters	Jatropha oil	Palm oil	Coconut oil
Viscosity 25 ^{0}C (mm^{2}/s)	31.00a	30.00^{a}	42.00^{ab}
Viscosity30 ^{0}C (mm^{2}/s)	29.00^{ab}	26.50^{ab}	31.50^{abc}
Viscosity 35 ^{0}C (mm^{2}/s)	23.00^{ab}	26.00^{ab}	29.00^{abc}
Viscosity 40 ^{0}C (mm^{2}/s)	21.34^{b}	23.33^{c}	20.50^{d}

aa: No significant, ab and other letters : Significance different P< 0.05.

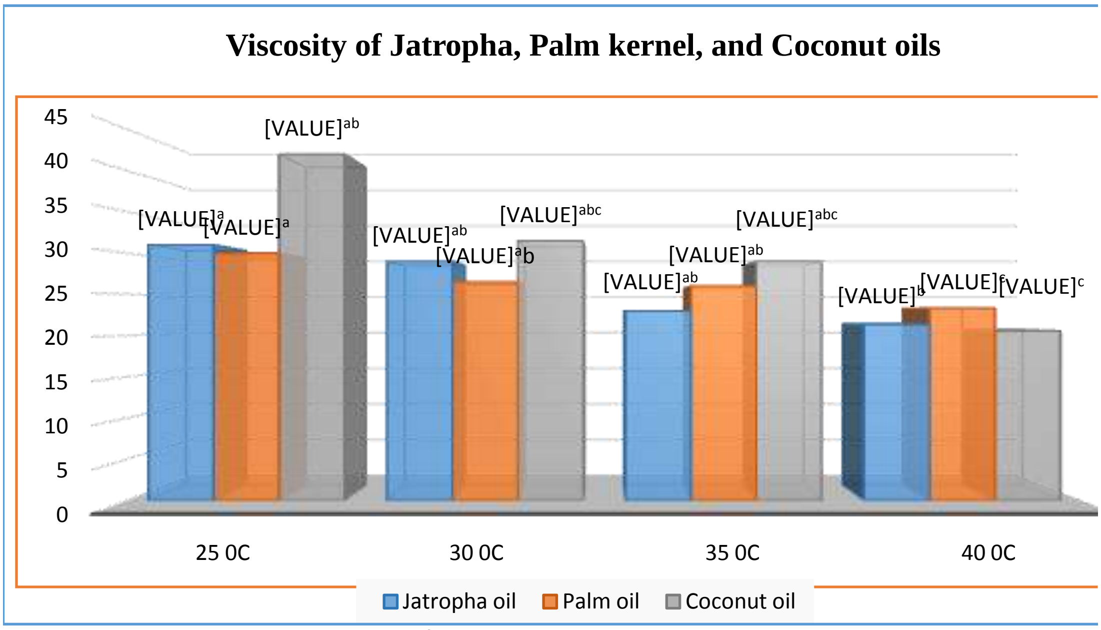

Fig1. Viscosity of Jatropha, Palm kernel, and Coconut oils

IV. Conclusion

This present study stablish that the temperature has high significant effect on reducing viscosity of vegetables oils. Heat oil at 40°C has better than 25, 30, and 35°C for decrease viscosity values, therefore, is suitable for producing biodiesel. However, the Jatropha and Palm kernel oils are better than coconut oil for producing biodiesel.

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