Apparent Viscosity Measurement of Patchouli Oil and Mixture at Athmospheric Pressure and Room Temperature

Elin Yusibani[1*], Peter Llyod Woodfield[2], Lena Ardiah[1], Muhammad Syukri Surbakti[1] and Rahmi[3]

[1]Physics Department, Faculty of Mathematics and Natural Science, Universitas Syiah Kuala, 23111 Indonesia
[2]Griffith School of Engineering and Built Environment, Gold Coast Campus Griffith University, QLD 4222 Australia
[3]Chemical Department, Faculty of Mathematics and Natural Science Universitas Syiah Kuala, 23111 Indonesia

*Corresponding Author: e_yusibani@unsyiah.ac.id

Abstract. Patchouli is an essential oil used in perfumes, cosmetics, soaps, insect repellents and also one of the candidates for biodiesel from non-edible oil. Patchouli oil from Aceh Province, Indonesia, is generally produced using a distillation process. The relation between physical properties, i.e. viscosity, and quality of the Patchouli oil from Aceh Province and mixtures with other oils is investigated in the present research. The mixture oils are palm oil, kerosene and lubricant oil SAE 40. The mixture compositions are 100:0; 75:25; 50:50; 25:75 and 0:100 (v/v). It is found that viscosity of patchouli oil mix with palm crude oil of 25% and lubricant oil of 25 % will increase the viscosity about 41% and 72%, respectively, and will decrease for 53% when it is mixed with 25% kerosene. Patchouli Alcohol (PA) and iron (Fe) content in the sample of patchouli oil can influence the value of viscosity by up to 17%
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Keywords: *AAS; GC; Mixture; Patchouli Oil, Viscosity.*

1 Introduction

Essential oil is one type of vegetable oil that has physical characteristics including a thick liquid form, volatile content and a distinctive aroma [1]. One type of essential oil found in Indonesia is patchouli oil. Patchouli oil is one type of essential oil produced from the steam distillation of dried leaves of patchouli plants (*Pogostemon cablin Benth*). Patchouli oil is usually used in the perfume

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industry [2] and in drugs. It is also being considered as one of the vegetable oils that have the potential to be used as biodiesel. Biodiesel is an environmentally friendly fuel consisting of alkyl esters from fatty acids that can be made from vegetable oils as well as animal. In biodiesel, viscosity is one of the important properties that shows material resistance to shear or flow [3]. Fuels that are too low in viscosity will provide poor lubrication and tend to cause leaks in the engine. Conversely, viscosity that is too high will cause dirty smoke because the fuel is slow to flow and harder to atomize [4]. Atabani (2013) measured the density and viscosity of patchouli oil from Aceh province. The density was 946.6 kgm^{-3} and the kinematic viscosity coefficient was 9.8175 mm^2s^{-1} at 40^oC. Using these data as a reference, further measurements were made regarding patchouli oil from Aceh province. The viscosity measurement was carried out on pure patchouli oil found in several districts in the province of Aceh. This was done to see the potential of patchouli oil produced by the community. Patchouli oil producing districts in Aceh Province include Aceh Jaya, Aceh Selatan (South Aceh), Aceh Barat (West Aceh), Gayo Lues and Aceh Tenggara (Southeast Aceh). Distillation processes are used to produce the oil. It is very simple to distill the oil and yet the procedures for doing so are diverse. The different methods of distillation and the geographical location of each district produce a variety of patchouli oils with differing qualities. These quality differences must follow one of the standards that Indonesia has carried out through the Indonesian National Standard (SNI) 06-2385-2006. SNI has standard values including color, density, refractive index, solubility in ethanol, acid number, ester number, optical rotation, patchouli alcohol, alpha copaene and iron content. In addition, the price of patchouli oil in the market is relatively expensive compared to other oils. Because of this, sellers often commit fraud by mixing patchouli oil with other types of oil thus it reduce the purity of the oil. In the article written by Martsiano, oil mixtures that are often used include palm oil and lubricant oil [5]. Based on the description above, in this study it is

necessary to measure apparent viscosity of patchouli oil when it mixed with other materials. In addition, studies will also be conducted on the viscosity coefficients on some important characteristics of patchouli oil, i.e. patchouli alcohol (PA) and iron content of the sample.

2. Methodology

The apparent viscosity of the samples were measured by a rotational viscometer L-Version (Thermoelectron karlsrune gmbh viscotester C type 399-0301-Spindel LV2, uncertainty of the measurement of 0,1 mPas). Patchouli oil (PO) was taken from three districts of Aceh province, Indonesia, i.e. Aceh Besar, Aceh Selatan (South Aceh) and Gayo Lues. To investigate differences in purity to the apparent viscosity values, mixing was carried out with the mixture composition was 100:0; 75:25; 50:50; 25:75 and 0:100 (v/v). Palm oil (PLO), kerosene (KR) and lubricant oil SAE 40 (LO) was used as a mixture materials and obtained from Banda Aceh. They were chosen to be mixed because they are readily available and relatively cheap. Density measurement was done with piknometre of 50 ml. All of the measurements were done under ambient conditions (0.1 MPa and 303 K). Iron (Fe) content in patchouli oil from Aceh Province was measured by Atomic Absorption Spectroscopy (AAS) by flame technique (AAS PinAAcle 900 H from Perkin Elmer). In this process, patchouli oil is prepared in quantities as large as 5 g and then mixed with 10 ml of nitric acid. This is done to be able to separate oil with Fe elements in patchouli oil. Mixing is done for approximately 1 h (until the oil and Fe elements are separate). During separation, the oil in patchouli oil will harden leaving the solution yellow. The solution was filtered and diluted using approximately 30 ml of distilled water. Patchouli alcohol (PA) content in a sample was measured using Gas Chromatography (GCMS-QP 2010 Ultra from Shimadzu). Gas Chromatography (GC) analysis is based on the separation of compounds. In GC there are two phases, one phase will be carried out by gas while the other phase

will be in the column. When passing a column, the compound will come out based on how long the compound can be held by the column. This causes a difference in retention time. Compounds with different retention times are read by the detector and matched with the database.

3. Results and discussion

The density measurement of the patchouli from Aceh province varied from 925 to 942 kgm^{-3} and the apparent viscosity varied from 14 to 17 mPas as can be seen in the Table 1. Figure 1 shows the density of the patchouli oil, it is found that the density decreased about 2% when lubricant oil was added for every 25% volume of the sample and it decreased by about 1-2% when palm oil was added for every 25% volume and about 4% when mixed with kerosene for every 25% volume, respectively. Figure 2 shows apparent viscosity measurement with the present viscometer. It is found that apparent viscosity of patchouli oil mix with palm crude oil of 25% volume and lubricant oil of 25 % volume will increase the viscosity about 41% and 72%, respectively, and will decrease for 53% when it mix with kerosene of 25% volume.

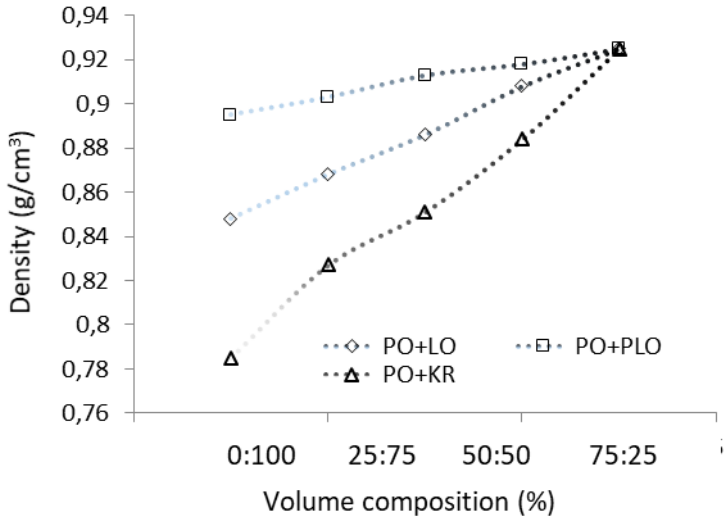

Fig. 1. Density measurement with the composition of the added mixture for every 25% volume of the patchouli sample from Aceh Besar district. Patchouli oil give a higher value of density among the other oils meanwhile kerosene has the lowest one. Decreasing density value is up to 4%.

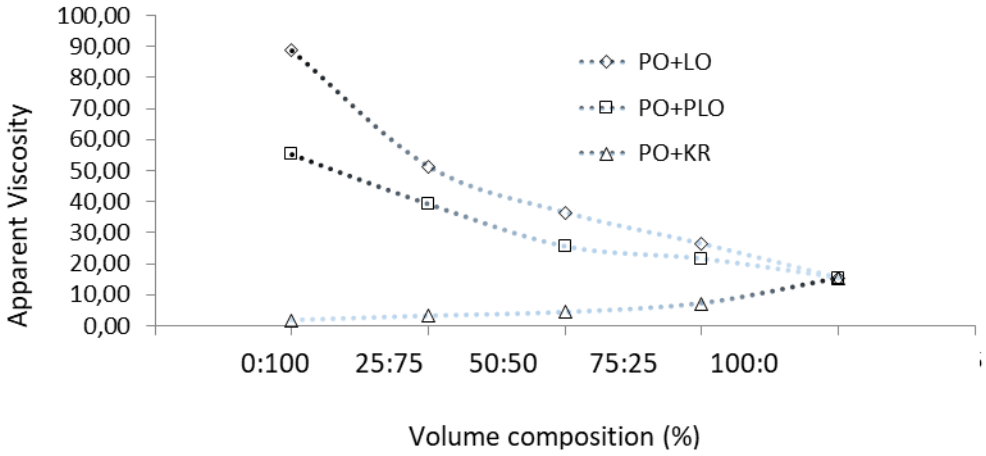

Fig. 2. Apparent viscosity of the mixture. Kerosene has a lowest value while lubricant oil is the highest one. The apparent viscosity changes gradually when the composition increases for every 25% volume of the mixture

Table 1. Density and apparent viscosity measurement of the pure samples

Sample	Density(kg/m3)	Viscosity(mPas)
PO from Aceh Selatan	942	16,7
PO from Aceh Besar	925	15,3
PO from Gayo Lues	934	14,3
PLO	895	55,3
LO SAE40	848	88,7
KR	785	1,8

Aisyah (2008) states that patchouli oil consists of typically 15 components identified, where the five biggest percentages are patchouli alcohol (32,60 %),

d-guaiena (23,07 %), a-guaiena (15,91 %), seychellena (6,95 %) and a-patchoulena (5,47 %) [6]. These five major components were also identified by Corine & Sellier (2004) [7]. Patchoulol (C15H26O) is a maker compound responsible for the patchouli oil scent, this representing around 40-50%. A simulation of the patchouli oil extraction process using patchoulol as a modeled molecule in different solvents, namely acetone, ethanol, and hexane has been done by Adam et al. The simulation aim is to recognize molecular interaction between patchoulol molecules with solvent molecules through hydrogen bonding and also the repulsion forces between them due to the abundance of hydrogen atoms in the patchoulol molecule [8]. Table 2 give a chromatogram result of patchouli oil from the present research and from another researcher. The five major components are also identified. Based on the GC result it is found that Patchouli oil from Aceh Selatan has 21 peaks and followed by Aceh Besar of 18 peaks and Gayo lues has only 15 peaks, respectively (Fig. 3). Patchouli alcohol began to appear in minutes 16-17 with a peak at minutes 17,340 - 17,466 in the present data. Kusuma & Mahfud (2017) have extracted patchouli oil from East Java province, Indonesia using a microwave hydro distillation method as a new green technique (with and without air) [9]. As can be seen in Table 3, patchouli alcohol from Aceh province has a relatively bigger value than that found by the other researcher. Particularly, patchouli oil from Aceh Besar district has the highest patchouli alcohol content of 42.61%.

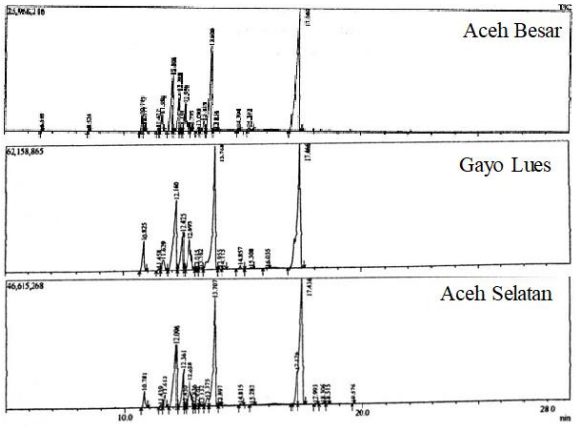

Fig. 3. Result of GC measurements to estimate patchouli alcohol content in the sample

Table 2. The major composition identified by GC for patchouli oil from Indonesia.

Name	Aceh Besar	Aceh Selatan	Gayo Lues	Trenggalek, East Java, Indonesia	
		Area (%)		MHD*	MAHD*
α-Gurjunene	2.33	-	-	12.18	11.57
Trans-Caryophyllene	5.06	4.38	2.32	-	-
b-Caryophyllene	-	-	-	4.63	5.42
Aromadendrene	12.89	14.57	-	-	-
Seychellene	6.99	5.96	6.49	8.42	8.41
α-Patchoulene	6.56	6.40	-	11.13	11.54
b-Patchoulene				2.87	6.56
DehydroAromadendrene	19.20	-	-	-	-
Patchouli Alcohol	42.61	34.85	33.04	26.32	25.23
Calarene	-	2.61	11.91	-	-
d-Guaiene	-	22.62	27.03	14.69	11.89
Naphthalene	-	6.29	-	-	-
a-Guaiene	-	-	17.16	-	-
Valencene	-	-	-	3.77	-
Viridiflorol	-	-	-	5.93	5.59
1-(Propen-2-yl)-4-methylspiro[4.5]decan-7-one (isomer B)	-	-	-	2.64	2.34

* microwave hydrodistillation (MHD) and microwave air-hydrodistillation (MAHD) [7]

Analysis report by AAS show that patchouli oil from Aceh Besar has a biggest Iron (Fe) content as is also apparent in Table 3. This is strongly related to the distillation process. In addition, the metal content of iron (Fe) contained in patchouli oil can also be seen from the color of it. Where, the more metal (iron) content in patchouli oil, the darker the color (Fig. 4). Figure 5 shows the apparent color of mixture with 50:50 (v/v) compositions of patchouli oil (Aceh Besar) with kerosene, palm oil and lubricant oil. From the figure we can see that there is no significant difference among them after e components are mixed. Thus we should take care when drawing conclusions after analysing samples that are suspected of being diluted with other oils. On the other hand, Patchouli Alcohol (PA) and Fe content in the sample of patchouli oil can influence the value of viscosity up to 17% as can be seen in the Table 4.

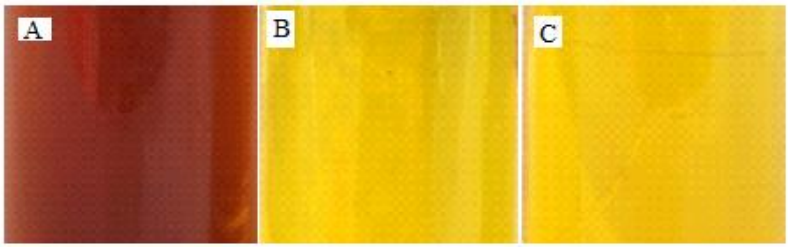

Fig. 4. Effect of iron content to the apparent color of the patchouli oil from (a) Aceh Besar, (b) Gayo Lues and (c) Aceh Selatan

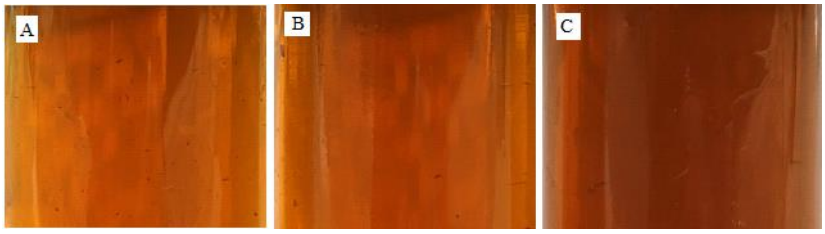

Fig. 5. Apparent color of mixture with 50:50 compositions of patchouli oil (Aceh Besar) with (a) kerosene (b) palm oil and (c) lubricant oil SAE 40. From the figure we can see there is no significant different among them

Table 3. Summary of Patchouli Alcohol and Fe content measurements in patchouli oil sample from various researcher

Reference	Patchouli Alcohol (%)	Fe (ppm)
Aceh Selatan	34.85	3.467
Aceh Besar	42.61	63.84
Gayo Lues	33.04	6.103
Ref [10] sample A	-	0.5611
sample B	-	0.431
sample C	-	0.799
sample D	-	6.020
Ref [11]	31.09	-
Ref [12]	22.98	-

Note: sample A:=patchouli leaf, sample B=distilled with glass tube, sample C= distilled with stainless steel tube and D= distilled with steel tube

4 Conclusion

The measurements using a rotational viscometer for patchouli oil from Aceh province show that the value of the apparent viscosity coefficient of South Aceh is relatively high compared to Aceh Besar and Gayo Lues. As for mixed patchouli oil, it is found that patchouli oil mixed with kerosene will give a low viscosity coefficient value compared to patchouli oil mixed with palm oil or lubricant oil. Based on the measurements by GC and AAS it is conclude that patchouli alcohol content and iron content in patchouli oil have an effect on the viscosity of patchouli oil, i.e. the viscosity tends to increase with increasing iron content and patchouli alcohol content in the sample.

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