Journal of Vocational Studies on Applied Research

Utilization of *Aluritics trisperma* Oil as Biodiesel

Gustry Ratna Sari[1*], M Akbar Satrio[1], Rizki Mulyaningsih[1], Imer Ayu Irene[1], Vita Paramita[2]

[1] Diploma III Programme of Chemical Engineering, Vocational School, Diponegoro University
[2] Department of Industrial Chemical Engineering, Vocational School, Diponegoro University

e-mail: imerayui@gmail.com

Abstract- *Biodiesel is one of the solutions to the many uses of fossil fuels. Biodiesel itself is a fuel derived from vegetable oil (plant or vegetable fat) called biofuel. In this study, biodiesel used is based on sunan candlenut. The purpose of this study was to determine the optimum time conditions (1.5; 2; 2.5 hours) and the comparison of solvents with candlenut (0.25; 0.2; 0.17) in the manufacture of candlenut oil, as well as knowing the process of making biodiesel. The method used is the manufacture of hazelnut oil by extraction using Soxhlet. The resulting oil was esterified using methanol with sulfuric acid catalyst at a reaction temperature of 60˚C for 60 minutes. The volume ratio between oil and methanol is 4: 1 followed by transesterification at 50˚C for 30 minutes. In the research, the results were optimum time and the number of solvents for good extraction at 2 hours and the ratio of solvents to hazelnut was 0.17. The resulting biodiesel density was 0.82 gr/ml, viscosity was 4.07Cp, FFA value was 1.4%, and the saponification rate was 274.4. From these data it can be said that the Biodiesel produced is approaching the Indonesian National Standard.*

Keywords - *Biodiesel, sunan candlenut oil, esterification, transesterification*

Submission: April 28, 2020 Correction: May 15, 2020 Accepted: May 20, 2020

Doi: http://dx.doi.org/10.14710/jvsar.v2i1.7677

[How to cite this article: Sari, G.R., Satrio, M.A., Mulyaningsih, R., Irene, A.I., and Paramita, V..(2020). Utilization of *Alurities trisperma* Oil as Biodiesel. *Journal of Vocational Studies on Applied Research, 2*(1), 16-22. doi: http://dx.doi.org/10.14710/jvsar.v2i1.7677]

1. Introduction

The depletion of the supply of fuel originating from the ground (fossil), the renewable energy sources derived from plants are expected to be able to replace the source of fuel originating from the ground (fossil). One of the most potential plants as a source of vegetable oil is the Sunan candlenut (Alaurites trisperma blanco). In the sunan candlenut seeds contain about 50% oil yield [10].

Biodiesel is a fuel derived from vegetable oil or commonly referred to as Biofuel. Biodiesel can used as a solution to overcome the problem of the depletion of fuel originating from the ground (fossil). Because biodiesel comes from plants or vegetable fats. Biodiesel has smaller side effects compared to fossil fuels. Then biodiesel is also more environmentally friendly compared to fuel in general.

Most of the Sunan Candlenut oil content is in the seeds. To get the oil, the seed core must be extruded first. The content contained in Sunan Candlenut oil includes palmitic acid, stearic acid, oleic acid, linoleic acid, and α-elaeostearic acid. Crude oil from the core of Sunan Candlenut seeds is used as biodiesel.

The results of Djeni Hendra's research entitled "Utilization of Biodiesel from Sunan Candlenut Seeds" is to make biodiesel from Sunan Pecan seed oil which produces quality that is in accordance with the standard requirements of biodiesel, which obtained a water content of 0.05%, acid number was 0.66 mg KOH/g, free fatty acid content 0.33%, density 874 kg/m^3, Kinematic viscosity at a temperature of 40^{o}C 4,24 mm^2/s (CST), iodine number 91,20 g I_2/100 g, cetane number 64 and the yield of biodiesel oil produced by 79,68%.

The purpose of our research is to determine the optimum time conditions (1.5; 2; 2.5 hours) and the ratio of solvents to candlenut (0.25;0,2; 0,17) in making candlenut oil, and knowing the process of making biodiesel.

2. Experiment

2.1 Materials

The main ingredient used is Sunan hazelnut seeds. While the other ingredients are n-hexane, boiling stone, NaOH, KOH, Indicator PP, Methanol, H2SO4, Water.

2.2 Tools

The tools used are mortar and pestle, digital scales, filter paper, sokhlets, clamps and statives, boilling flasks, basins, spoons, glass watches, electric stoves, measuring cups, condensers, hoses, erlenmeyers, ovens, thermometers, beaker glass, viscometer, suction ball, dropper, pycnometer and separating funnel.

2.3 Procedure

Extract of Sunan Candlenut Oil

Table 1. Variable Extract of Sunan Candlenut Oil

Fixed Cost	Variable Cost
Sunan Candlenut (gr)	Time (hour)
100	1,5
100	2
100	2,5
100	1,5
100	2
100	2,5
100	1,5
100	2

Sunan candlenut seeds that have been mashed, then weighed as many variables and then wrapped using filter paper and then put into sokhlet. Enter n-hexane into a three-neck boiling flask according to the variable. Then assemble the sokhlet tool. The extraction process is carried out by maintaining a temperature of 69^{o}C with a variable time.

Destilation

Arrange the distillation tool, then pour the sunan candlenut oil which is still mixed with n-hexane into the distillation flask.The distillation process takes place with an operating temperature of 70oC until the oil is separated from n-hexane completely.

Making Biodiesel

Oil Esterification

The esterification process is carried out by reacting oil with methanol at a volume ratio of 4: 1, ie 50 ml: 12.5 ml with a 3 ml sulfuric acid as catalyst at 60^{o}C for 1 hour.

Oil Transesterification

The transesterification process is carried out by reacting the esterified oil with methanol at a 4: 1 volume ratio using a Potassium Hydroxide as catalyst for 30 minutes at 50^{o}C.

Biodiesel Purification

Biodiesel Purification is carried out by decantation using a separating funnel. Then proceed with evaporation at 50˚C in a vacuum which aims to separate biodiesel from unreacted methanol. Continue washing biodiesel with warm water to separate impurities. Then do the heating to evaporate the water contained in biodiesel.

3. Results and Discussion

Result Table of Observations

Extract Oil Volume

The analysis result is shown in Table 2. Those data show the volume of oil is decrease even in ratio 1:4, 1:5, and 1:6. It is caused by large amount n-hexane solents that have evaporated because of the alumunium is not covered well, so that the volume of oil extraction is decrease. In the theory of evaporation, heating in a liquid increases the volume of motion of a liquid so that the bonds between liquid molecules are not strong and will make it easier for the liquid molecules to break away from the group that is detected as evaporation.

Density Test

Density or specific gravity is a measure of mass per unit of volume (oil or fat). Density that we have got at a ratio of 1: 4 and 1: 5 experienced a fluctuation and at ratio of 1:4 (140.68; 49.6; 62.43) at a ratio of 1: 5 (52.8; 58.79; 45.69). In the ratio of 1: 6, it increased (53.3; 58.23; 50.07). Sunan candlenut oil density according to Djeni Hendra is 0.985 where our group is very far from the research value of Djeni Hendra.

Viscosity Test

The viscosity of Sunan Candlenut which is determined by the Indonesian National Standard (SNI) is not specifically determined, so compared to the viscosity of sunan candlenut oil obtained based on the Djeni Hendra experiment that is 26.57 cSt and in the Djenar and Lintang experiments obtained viscosity of 69.55 cSt (40˚C). These result can be caused by differences in the processing of Sunan Candlenut Oil. In the Djenar and Lintang research, extraction was carried out using Soxhlet followed by purification with degumming and neutralization using NaOH.

Yield Test

Yield uses percent (%) units. The higher the yield value produced indicates the value of the extract produced more and more. The quality of the extract produced is usually inversely proportional to the amount of yield produced. The higher the yield value produced, the lower the quality obtained. The yield of sunan candlenut which is determined in accordance with the Indonesian National Standard (SNI) is not specified specifically, so that it is compared with the yield of sunan candlenut oil obtained based on Djeni Hendra's experiment which is 43.33%. The difference in yield is due to the processing of Sunan candlenut oil extraction.

Free Fatty Acid Test

The Sunan candlenut FFA which is determined in accordance with the Indonesian National Standard (SNI) is not specifically determined, so compared to the FFA of sunan candlenut oil obtained based on the Djeni Hendra experiment which is 6.63%. The value of% FFA obtained from previous studies is very different, this is because %FFA is influenced by raw materials, thus affecting the results of %FFA for each variable, so that its development requires further research [16]. From the data above shows that the sunan candlenut seed oil has a high %FFA, so for conversion of sunan candlenut seed oil to biodiesel treatment needs to be done on the sunan candlenut seed oil before it is used as biodiesel feedstock.

Table 2. Result Table of Observations

Run	Fixed Cost	Variable Cost		Parameter Level					
	Sunan Candlenut (gr)	Time (hour)	Solvent (ml)	Oil Volume (ml)	Density (gr/ml)	Viscosity (Cp)	Yield (%)	FFA (%)	Saponification
I	100	1,5	400	10	140,68	0,904	10.08	14	224
II	100	2	400	5	49,6	0,988	19,86	7	252
III	100	2,5	400	4	62,43	1,003	16,85	5,6	257,6
IV	100	1,5	500	6	52,8	0,974	25,51	8,4	215,6
V	100	2	500	5	58,79	0,976	27,27	5,6	240,8
VI	100	2,5	500	3	45,64	0,947	25,77	5,6	257,6
VII	100	1,5	600	11,5	53,3	0,98	19,21	16,1	246,4
VIII	100	2	600	7	58,23	0,983	23,95	9,8	257,6
IX	100	2,5	600	4	50,07	0,978	24,63	5,6	257,6

Table 3. Biodiesel

Variable	Parameter Level						
n-hexane volume	Time (hr)	Oil Volume (ml)	Density (gr/ml)	Viscosity (Cp)	Yield (%)	FFA (%)	Saponification
600	2	7	58,32	0,983		23,95	9,8

Saponification Test

The saponification number is expressed as the number of milligrams (mg) of KOH needed to lather one gram of fat or oil. The saponification number is also a measure of the average molecular weight of triglycerides that make up the oil component. Oil which has a relatively small molecular weight will have a large saponification number and vice versa oil with a large molecular weight has a relatively small saponification number. HCl titrant is needed to neutralize the remaining unreacted KOH alkoholis. The large volume of titrant needed can be concluded that there are still a lot of free fatty acids, so that the saponification number obtained is low and vice versa. The saponification numbers obtained is fluctuation.

Biodiesel

According [14] in general non-food vegetable oils such as jathropa, pongamia contains very high FFA, as well as Sunan candlenut oil. The high content of FFA will increase soap formation, decrease catalyst performance and make it difficult to separate glycerol from biodiesel. In this regard, the esterification of Sunan candlenut oil which is the main research can reduce the FFA content of hazelnut oil so that it can proceed to the next process, namely transesterification to produce biodiesel. The density of vegetable oils will increase with the increase in the number of double bonds (unsaturated) fatty acids [7]. Sunan candlenut oil contains high unsaturated fatty acids, including oleic acid and linoleic acid (Canrika and Dian, 2009). At the time of esterification these acids are converted to ester compounds (methyl esters) which reduce the density of the hazelnut oil.

In making biodiesel using the 8th experiment, the volume of n-hexane 600 ml for 2 hours, where the esterification stage is carried out first by reacting oil with methanol at a volume ratio of 4: 1, is 50 mL: 12.5 mL with H2SO4 catalyst as much as 3 mL at 60°C for 1 hour. After esterification, it is continued with transesterification.This process is carried out in stages, so that the amount of methanol as a reactant can be minimized and it is an increase in methyl esters is expected [7]. Characteristics of biodiesel that produced from transesterificatio can be seen in the table above where a Density of 0.82 gr / ml is obtained, which is almost in accordance with SNI Biodiesel, which is 850-890kg/cm^3. Viscosity obtained was 4.07Cp and kinematic viscosity was 2.86 which was in accordance with SNI Biodiesel standards which was 2.3-6.0. The FFA value in our practicum is 1.4%. The value of the saponification number obtained by our group is 274.4 where in SNI the saponification number is not specific so compared to the Djeni Hendra experiment which is equal to 101.49 mgKOH/gr.

Effect of Length of Time vs Volume of Oil Produced

In figure 1 obtained, it can be seen that both the candlenut ratio and n-hexane are 0.25; 0.2; and 0.167 has decreased, which is not in accordance with the theory. According [9] the longer the distillation process is carried out, the more distillates are produced. At our lab work the temperature is maintained at 70 ° C to get the level of success in the process of purifying the material. Discrepancy with this theory is due to the large number of n-hexane that evaporates so that in the process is carried out the addition of n-hexane continuously. Like theory on evaporation, where heating of a liquid can increase the volume of motion of a liquid so that the bonds between liquid molecules are not strong and will make it easier for the liquid molecules to break away from their groups which are detected as evaporation. So the longer the operating time, the more steam is contained.

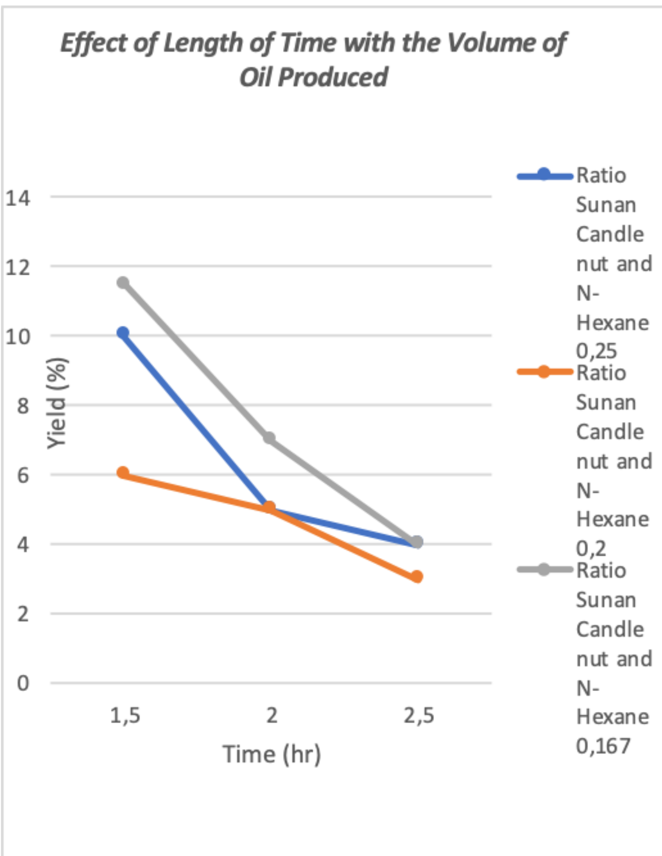

Figure 1. Effect of Length of Time with the Volume of Oil Produced

Effect of Length of Temperature vs Density

In figure 2 obtained, can be seen both on ratio between candlenut and n-hexane 0.25; 0.2; and 0.167 that density that we have is fluctuative, where this has not been in accordance with the theory that the higher of distillation temperature, the smaller the density, so that, the higher the residual content in the distillate/the more air content in n-hexane. According [11] the higher distillation temperature reduces the levels of impurities in oil. With the reduced water content causes higher oil density so that the flowing electric field will be more difficult to reach electricity, therefore the higher the distillation process, the higher the breakdown voltage value. While the value of the smaller density also increases the value of oil content in oil.

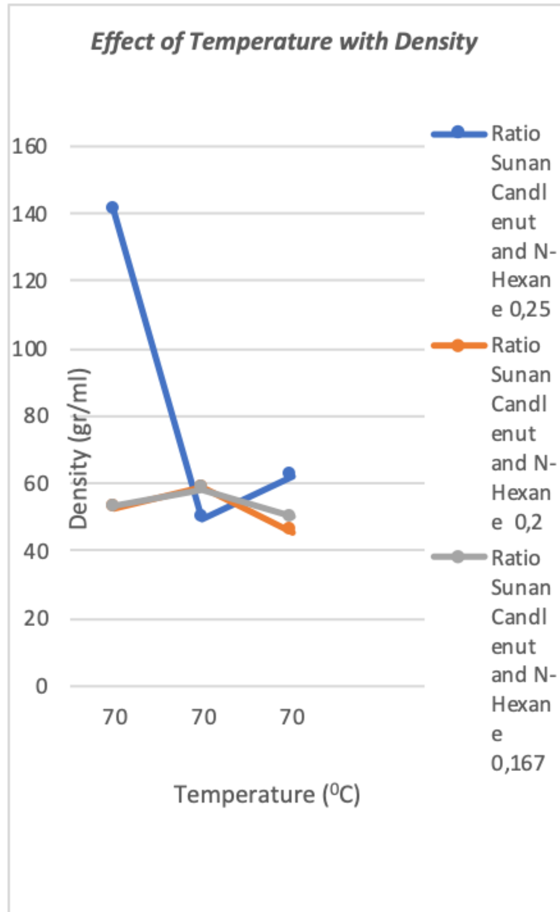

Figure 2. Effect of Temperature with Density

In the journal a density of 985.49 kg/m3 was obtained for crude oil from sunan candlenut seeds. The results produced in the journal are very different from the results we get.

Effect of Length of Time vs Viscosity

In figure 3 obtained, it can be seen that both the candlenut ratio and n-hexane are 0.25; 0.2; and 0.167 fluctuated. Where should the longer the time the more viscosity is also produced. This mismatch is caused by the process between heating and the time measuring the viscosity too far. It could also be due to the low-level of accuracy because in this experiment we used a thermometer to regulate the temperature

In the journal the viscosity obtained was 26.57 cSt for crude oil from sunan candlenut. The results obtained are far different from the results we get at the lab.

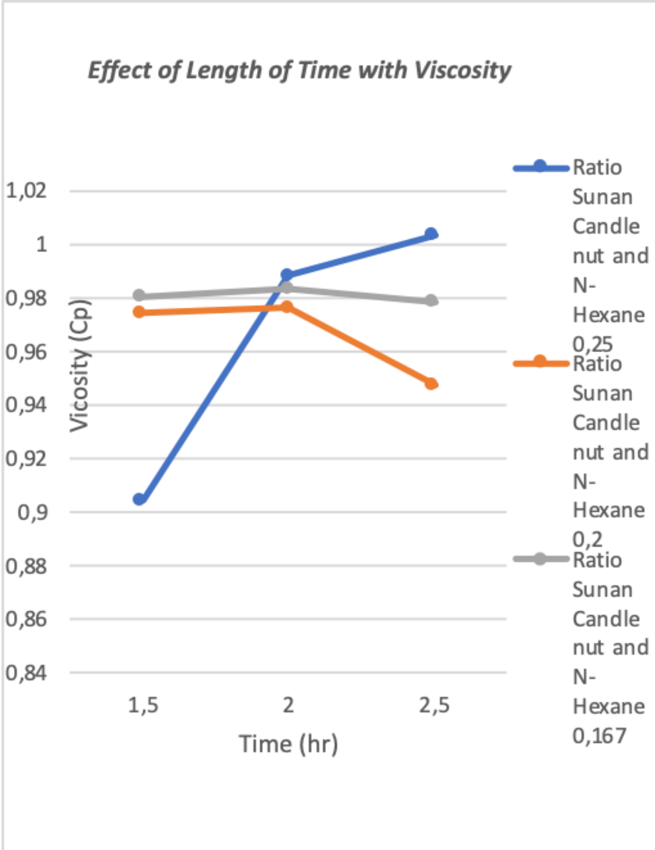

Figure 3. Effect of Length of Time with Viscosity

Effect of Temperature with Yield

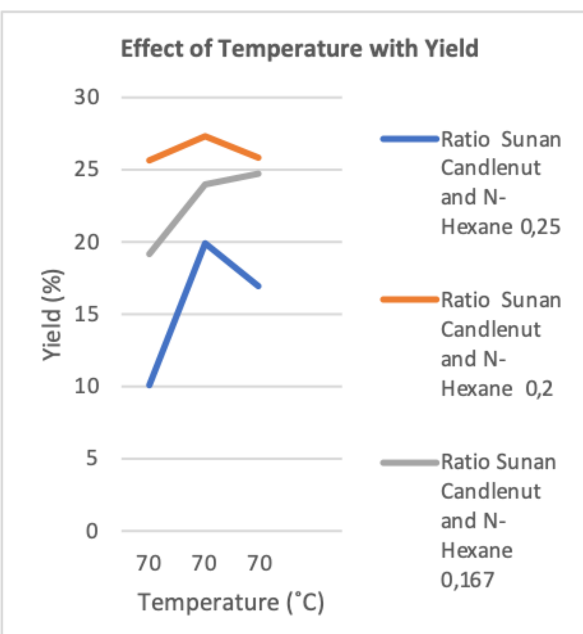

Figure 4. Effect of Temperature with Yield

According [21], the amount percent of yield produced effect in the quality of the oil produced. The higher the extraction temperature, the higher the yield. Where the higher the yield, the lower the quality of oil obtained. The solubility of solids /liquids affect hotter, the higher the temperature the greater the solubility. It can be seen on the Figure 4 displayed in our group is fluctuative . In the journal yield obtained value of 43.33%. The results obtained in the journal are not much different from what we get in the lab work. This can occur because the handling is the same in the yield test.

Effect of Temperature with Free Fatty Acid

According [21] %FFA tends to increase along with the high extraction temperature which is done both using n-hexane. The size of the %FFA affects the oil quality, where the higher the %FFA content, the oil will be difficult to purify because there are still many impurities such as phosphotides, partial glycerides, waxes and saponified compounds which are still mixed in extraction process and cause lower oil quality. It can be seen in the graph that the FFA value of our group is decreasing.

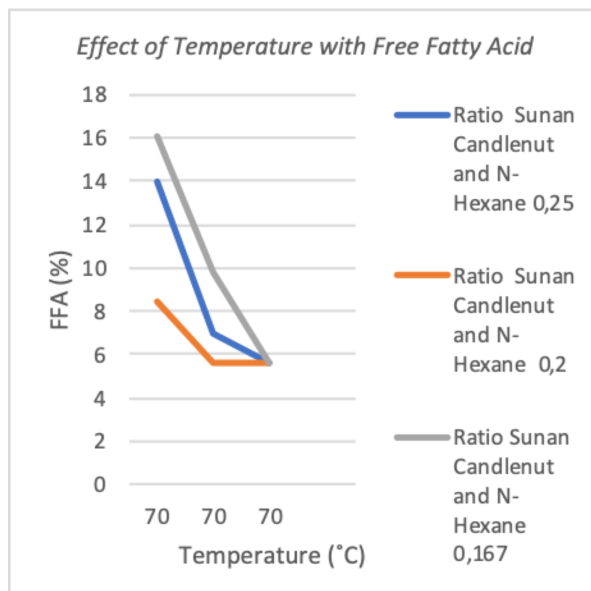

Figure 5. Effect of Temperature with Free Fatty Acid

In the journal, the FFA yield was 6.63% in crude oil from sunan candlenut. The results obtained are not much different from the results we get on our lab work. This can be due to factors that are about similar between research in journals and lab work in our group.

Effect of Length of Time with Saponification

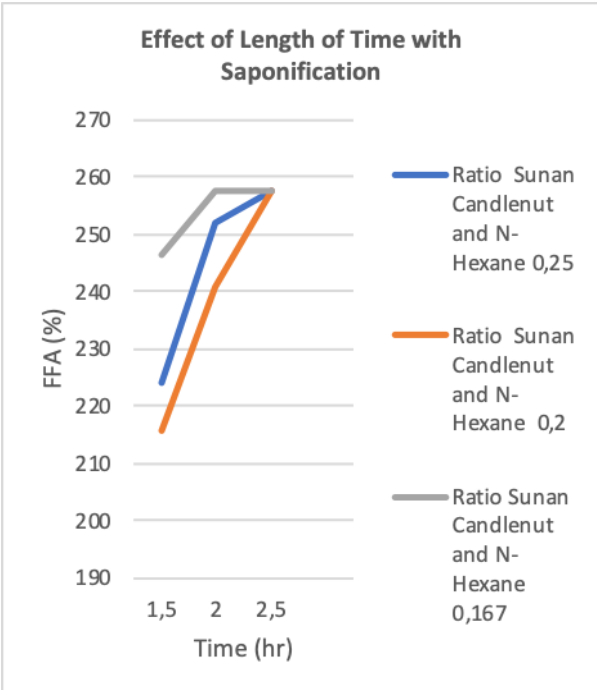

Figure 6. Effect of Length of Time with Saponification

In figure 6 obtained, it can be seen that both the candlenut ratio and n-hexane are 0.25; 0.2; and 0.167 can be concluded that each volume of solvent used and the length of time of extraction did not much affect the saponification number. According to [20], this is because the saponification number is only influenced by molecular weight. The higher the molecular weight, the lower the saponification number. The lower the saponification number, the better the oil quality will be. The highest saponification rate at 600 ml of n-hexane.

4. Conclusion

In making biodiesel, the best time and the number of solvents for good extraction is 2 hours and the ratio of solvents to candlenut is 0.17. The resulting biodiesel density is 0.82 gr/ml, viscosity is 4.07Cp, FFA value is 1.4%, and the saponification rate is 274.4.

5. Acknowledgment

Gustry, Akbar, Rizki, and Imer are so thankful to Mrs. Dr.Eng Vita Paramita,ST, MM, M.Eng who gives our tim many advice and information about this lab work.

References

[1] Asif dan Dibyo. 2012. *Karakteristik Biodiesel Kemiri Sunan [Reutealis trisperma (Blanco) Airy Shaw] Menggunakan Proses Transesterifikasi Dua Tahap. Balai Penelitian TanamanIndustri Dan Penyegar.*

[2] Ati'ah pratiwi, 2016. *Bab 2 pemanfaatan biodiesel, Prarancangan pabrik Metil Ester dari Minyak Jarak Pagar dan Metanol Kapasitas 65.000 ton/tahun. Universitas Muhammadiyah Surakarta.*

[3] Aunillah A., dan D. Pranowo. 2012. *Karakteristik biodiesel kemiri sunan (Reutealis trisperma [Blanco] Airy Shaw) menggunakan proses transesterifikasi dua tahap. Buletin RISTRI 3 (3): 193-200.*

[4] Badan Penelitian dan Pengembangan Pertanian (2009). *Tanaman perkebunan penghasil bahan bakar nabati (BBN)*. Bogor: IPB Press.

[5] Canrika, W & Dian, N. 2009. *Studi pendahuluan transesterifikasi secara bertahap dari minyak kemiri Sunan (Aleurites trisperma Blanco) menjadi biodiesel. Bandung: Jurusan Teknik Kimia Politeknik Negeri Bandung.*

[6] Dipyo P, dkk. 2015. *Potensi Pengembangan Kemiri Sunan (Reutealis trisperma (Blanco) Airy Shaw) Di Lahan Terdegredasi.*

[7] Djenar dan Lintang. 2012. *Esterifikasi Minyak Kemiri Sunan (Aleurites trisperma) Dalam Pembuatan Biodiesel. Bandung : Vol. 14, No. 3, November 2012: 215 - 221*

[8] Djeni Hendra. 2014. *Pembuatan Biodiesel dari Biji Kemiri Sunan. Bogor: Penelitian Hasil Hutan Vol. 32 No. 1, Maret 2014: 37-45 ISSN: 0216-4329 Terakreditasi*

[9] DK Utomo,dkk. 2012. *Uji Efektivitas Kolom Fraksinasi dan Pemvakuman Pada Prototype Teknologi Destilasi Bioetanol terhadap peningkatan kadar etanol.*

[10] Herman, M., Syakir, M., Pranowo, D., Saefudin, Sumanto. 2013. *Kemiri Sunan (Reutealis trisperma (Blanco) Airy Shaw) Tanaman Penghasil Minyak Nabati dan Konservasi Lahan. Jakarta: IAARD Press.*

[11] Kirana. 2017. *Pengaruh Variasi Suhu Destilasi Terhadap Karakteristik Minyak Jarak Sebagai Alternatif Isolasi Cair pada Transformator Daya*

[12] Lynch, S.J. 2011. *Notes on newer hard drying vegetable oil: from Aleurites trisperma Blanco and Garcia nutans Rohr. Florida State Horticultural Society: 152-156.*

[13] Maman,dkk. 2013. *Kemiri Sunan. Jakarta : IAARD Press*

[14] Mathiyazhagan, M., Ganapathi, B., Jaganath, B., Renganayaki, N & Sasireka, N. 2011. *Production of biodiesel from non-edible plant oils having high FFA content. International Jurnal of Chemical and Enviromental Engineering. 2 (2): 119-122.*

[15] Nurjanah, S., Lestari, D.S., Widyasanti, A., Zain, S. 2015. *The Effect of NaOH Concentration and Length of Trans- esterification Time on Characteristic of FAME from Reutealis trisperma (Kemiri Sunan). International Journal on Advanced Science Engineering Information Technology Vol 5(2015) No. 1: pp. 52-56*

[16] Pratiwi, Dewi dan Delfi Fatina S.. 2009. P*emanfaatan Minyak Hasil Ekstrak Biji Kelor (Moringa oliefera) untuk Pembuatan Bahan Bakar Nabati.* Universitas Sriwijaya: Inderalaya.

[17] Rangga.2018. *Analisis Kesesuaian Lahan Budidaya Kemiri Sunan (Aleurites trisperma) Di Kabupaten Lampung Selatan Provinsi Lampung.*

[18] Syakir, M., M. Herman, D. Pranowo, dan H.M. Hasibuan. 2015. *Budidaya dan Agribisnis Kemiri Sunan Sumber. IAARD Press, Jakarta: 109 hlm*

[19] Syafaruddin dan A. Wahyudi, 2012*. Potensi varietas unggul kemiri sunan sebagai sumber energi bahan bakar nabati*. Persfektif 11(1): 59-67

[20] Tamzil. 2009. *Pengaruh Pelarut Heksana dan Etanol, Volume Pelarut, dan Waktu Ekstraksi Teradap Hasil Ekstraksi Minyak Kopi.*

[21] Umi Latifah. 2018. *Pengaruh Jenis Pelarut dan Suhu Terhadap Ekstrak Minyak Bekatul Padi (Oryza Sativa).*

[22] Unggul priyanto, 2018.*Outlook energi indonesia 2018. Http:/www.researchgate.net/publication/327904911 outlook energi indonesia 2018 energi berkelanjutan untuk transportasi darat*

[23] Wang, R., Zhou, W-W., Hanna, M.A., Zhang, Y-P., Bhadury, P.S., Wang, Y., Song, Bao- An, Yang, S. (2012), *"Biodiesel preparation, optimization, and fuel properties from non- edible feedstock, Datura stramonium L", Fuel, Vol. 91, Hal. 182-186*

[24] Winata, E. dan Yunianta. 2015. *Ekstraksi Antosianin Buah Murbei (Morus alba L.) Metode Ultrasonic Batch (Kajian Waktu dan Rasio Bahan : Pelarut). Jurnal Pangan dan Agroindustri. 3 (2): 773-783*

[25] Xu, Y., dan Hanna, M., (2009), *"Synthesis and Characterization of Hazelnut Oil-Based Biodiesel", Biological Systems Engineering: Papers and Publications. Vol. xxx, Hal.114.*

[26] Yang, R., Su, M., Zhang, J., Jin, F., Zha C., Li, M dan Hao, X. (2011), *Biodiesel Production from Rubber Seed Oil Using Poly (Sodium Acrylate) Supporting NaOH as A Water-Resistant Catalyst, Bioresource Technology, Vol. 102, Hal. 2665-267*