International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 8 Issue 10 Series. II || October 2019 || PP 66-73

Study on Physico-Chemical Characteristics ofSome Plant Oils for Raw Materials of Biodiesel

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Abstract: *Physical-chemical characteristics of oils extracted from Jatropha (Jatrophacurcas.L), palm kernel (Elaeisguineensis), and coconut (Cocosnucifera) needs to be identified to assess their suitabilities as main raws of making biodiesel. Method of Mandal and Lee was employed to extract the raw materials, whilst method of Association of Official Analytical Chemistry International (AOAC) and American Oil Chemists Society (AOCS) were used to analyze the physical-chemical of their extracted oils; T-test was performed to evaluate the difference between data by SPSS Version 16. General results showed significant differences (P<0.05) between parameters of physical-chemical properties of the extracted oils with Indonesian National Standards (SNI) at P < 0,05, i.e.; significantly different in saponification, water content, ash content, and density of Jatropha and palm oils, whereas not significantly different in saponification, flash point, iodine, moisture, and ash content of coconut and palm oils. The colors of the oils were brawny yellow, brown, and yellow for Jatropha, palm and coconut, respectively. General results concluded that the suitability of palm oils as raw materials for making biodiesel was better than coconut oil which in turn also better than Jatropha.*

Keywords:*Jatropha, Palm kernel, Coconut,extraction, physic-chemical properties*

Date of Submission: 25-10-2019 Date of acceptance: 06-11-2019

I. Introduction

Alternative fuel such as biodiesel are a fuel made from renewable biological sources such as vegetable oils both (edible and non-edible oil) and animal fats (Raja et al., 2011). Biodiesel are renewable fuel made from vegetable oils and animal fats, which is recyclable. The suitable method of production biodiesel has been is alkaline trans-esterification of the oil or fats with alcohol (ApitaandTemu, 2013).

Fats and oils have been used by humans for food and other application sine old time. Which is renewable resources, they are the raw materials for food produces by food processors and restaurants and in the home (Brien, 2004). Fats and oils are created from construction wedges so-called triglycerides resulting from the grouping of one unit of glycerol and three units of fatty acids. It is insoluble in water but soluble in most organic solvents, and they have less than the density of water. Fats are animal products, while oils are vegetable products (Strayer et al., 2006).

Palm oil has been high-yield and production cheaper comparing with other types oils. Considered Malaysia is second biggest producer palm oil in the world, which is contributes to social and economic growth of its, based on contributed to gross national income of country (Lim et al., 2015). Palm oil has been now a major source of renewable sustainable and raw material for the world's food, oleochemical and biofuel industries. It has uplifted the quality of life of people after Involvement in cultivation activities, which is helped alleviate poverty among landless farmers in Malaysia (Basiron, 2007). Palm oil has been tallness between 20 - 25 m with life sequence of about 25 years. Which is a tropical plant, the reaches full production of plant after 8 years from establishing? Palm oil has two types of oil that production from the fruit; from pulp and kernel such as palm kernel oil and palm oil proper (Verheye, 2010).

The coconut oil can be obtained from the kernel of Cocosnucifera L., they are edible oil. They are used for edible and non-edible products such as cooking, bakery, confectionary, cosmetics and pharmaceutical (Kumar and Krishna, 2014). Plants of coconut are widely spread in throughout the tropics and in islands of pacific. Which is provides almost all the necessities of life food, drink, oil, medicine, fibre, timber, thatch, mats, fuel, and domestic utensils (Edward et al., 2006).

Jatropha plant has acclimates well to dry environments, they are needs little water and few additional attention; it is suitable for warm regions with little fertility. Jatropha plants have been become productive after 3 or 4 years, and their lifespan is about 50 years. Considered the Jatopha seeds are toxic and Jatropha oil is nonedible (Romano and Sorichetti, 2011).

Oil extraction has three methods of eliminating oil from raw materials: dry processing or wet processing, solvent extraction and traditional methods. Solvent extraction is not suitable for small-scale processing because high costs operating. Equipment for wet or dry processing is available at different scales of operation from household to industrial scale (Al kurki et al., 2008), (Gayas and Kaur, 2017), (Tony, 2008).

This study is very interested in the process of production of bio-fuels from food and non-food details, such as seeds of Jatropha, palm, and coconut, by determining their physical and chemical characteristics.

II. Materials and Methods

The research is planned to be conducted to on November 2015 to June 2016 at Postharvest, Pilot Plant, and ChemistryLaboratories of University of Padjadjaran.

The materials that were usedin this researchare: Seeds of (Palm kernels, Coconut fruits and Jaropha Seeds), filter paper, Hexane ($C_6H_{12}O_6$), sodium hydroxide (NaOH), methanol (CH_3OH), potassium iodine (KI), HCL, Phinonphthaline(pp), kalioum Hydroxide (KOH), chloroform. Acitic acid, Yodiuom bromide (BrI), Distiled water (DW), Sodium Di selphate ($Na_2S_2O_{4)}$, Hgo, H_2SO_4, K_2SO_4, $Na_2S_2O_3$, H_2O, H_3BO_3.

The equipment and tools that usedin this researchare: Soxhlet, Machine Press, digital Viscometer, Pycnometer, thermometer, Oven, sensitive balance, Centrifuge, Refrigerator, mixer, Water bath, Beakers, flasks, burets, pipets, dissector, Erlenmeyer, bottles, dropper, spatulas,conical flask.

Collection of Samples

Samples were collected from market in Bogor (palm kernels), Bandung (coconut fruits) West Java, and Palembang (Jatropha seeds) Sumatra Island- Indonesia.

Extraction Oil

Extraction oil was conducted according to methods of Mandal and Lee (2013). The Oil was extracted using cold press extraction with small scale "expeller" (temperatures 40-60°C).The filtered using (centrifuge).

Physic-Chemical Analyses of Extracted Palm Kernel Oil

Iodine value, The AOAC Official Method 993.20 (2005) (Wijs method) was used to determine the Iodine values, The Peroxide valueswill be determined according to the official method no. 965.33 of the Association of Official Analytical Chemist (AOAC), The saponification value of the palm oil kernel was determined according (AOCS, 1992) method of Norziah et al.,(2009), Free fatty acids value was determined according to the method describe in AOCS (1992) method, The density of the oils was determined according to A.O.A.C (2000), Official method 920.212), and dabo et al., (2013) method, The viscosity of the oils was determined by digital viscometer using spindle LI, rpm 100. Siddique et al.,(2010), the color characteristicsof the palm oil kernel were determined by sighting. Olaniyi, (2014), and the faty acid composition were determined by digital GCMS device according to method of Norizzahet al., 2014.

Statistical Analysis

The analyses were carried out in triplicates. Descriptive explanatory method will be employed to discuss the results. T-test will be performed to evaluate the difference between data by SPSS Version 16.

III. Results and Discussion

Oils recovery rate: Table 1 showed the results of oil yield obtained using mechanical presses. The extraction ratio of Jatropha, palm and coconut were 9, 24, and 53percent respectively. The coconut extraction ratio is higher yields compared to the other ratio palm, Jatropha, and the Jatropha extraction ratio is lower than other group. This different may due to moisture content of Jatropha 15.91percent and palm 7.69percent seeds, they have high moisture content than coconut 1.11percent, causes to process drying of Jatropha and palm seeds are not good because Jatropha and palm are cereals or grains, environment factor as lower temperature and high air humidity.This results agree with Orhevbaet al.,(2013) them reported that the seed kernels with higher moisture content yielded less oil as compared to those with lower moisture contents.Also this is study agree with Suganya et al.,(2013) mention that the different seed extraction techniques influence the oil yield and the seed oils properties. The oils recovery rate showed on table1 below.

Table 1: Oils Recovery Rate

Oil from	Fat contain (%)Yield (%)	
	Mechanical press	
Jatropha	19.84	
Palm	49.81	8.77
Coconut	72.40	23.96

Physic-chemical Properties of Jatropha and Palm kernel Oils

From the below Table 2 these results showed significant differences (P<0.05) of the Jatropha and palm oils between seven physic-chemical parameters. From these results obtained the density of Jatropha was 0.92±.01, palm kernel was 0.91±.01. From these results the density of Jatropha oil agrees with Raja et al. (2011), and disagrees with Ved and Padam, (2013). This different may due to climate and temperature. The saponification of Jatropha oil was 177.30±0.89 and palm oil was 215.74±1.29, from these results showed that saponification of palm oil is higher than Jatropha oil. This results shows that saponification is obtained from palm kernel oil is agrees with values for most vegetable oils ranging from 188 - 253 mgKOH/g. Oluba et al., (2008). Atasie and Akinhanmi, (2009). This different may due to genotype and molecular weight, also indicates that has potential application in the production of biodiesel, soap and shampoos. The iodine value of Jatropha oil was 38.14±2.62 and palm kernel oil was 22.81±0.23. Iodine value of Jatropha oil is higher than palm kernel oil. These results showed that disagree with Olyni et al., (2014) and Raja et al.,(2011), this different may due to environment, climate and soil. Also indicate to Jatropha oil has high unsaturation fatty acid percent. The peroxide value of Jatropha oil was 5.70±0.17 and palm kernel oil was 3.39±0.31, these results showed that Jatropha oil has higher peroxide value than palm kernel oil. These results disagree with Olyni et al., (2014), causes to high temperature during extraction, climate and rainfall. This is indicating to high level of rancidity of Jatropha oil. The FFA of Jatropha oil was 3.62±0.02 and palm kernel was 1.84±.04, from these results showed that FFA value of Jatropha is higher than palm kernel oil. The FFA of Jatropha oil agrees with Nzikouet al., (2009), and palm kernel FFA values agree with Olyni et al., (2014). The high FFA value of Jatropha oil indicate to highly acidic than palm kernel oil. The Jatropha oil color was tawny and palm kernel was brown. The color of oils is most probably May due to the extraction process and pigments content and could be removed by bleaching. However, the color of the oils is not an important factor in end use applications except in some cases where bright color is a prime consideration such as in pigmented coatings. The viscosity of palm kernel oil was 40.67±2.08and Jatropha oil was 28.33±0.58, this result showed that viscosity of palm kernel oil is higher than Jatropha oil. The viscosity of Jatropha oil disagrees with Raja et al., (2011) and viscosity of palm oil not matches with composition of palm kernel seed (protein and fats percent), this different may due to extraction method, dry seeds and temperature.

Table 2: Physic-chemical Properties of Jatropha and Palm kernel Oils

Parameters	Values		
	Jatropha oil	Palm kernel oil	SNI
Density 25^0C (g/cm³)	$0.92±.01^a$	$0.914±.01^a$	0.87 – 091
viscosity 27^0C (mm^2/s)	$28.33±0.58^a$	$40.67±2.08^b$	Max. 36
Saponification value (mgKOH/g)	$177.30±0.89^a$	$215.74±1.29^b$	180 – 265
Peroxide value (mgKOH/g)	$5.70±0.17^a$	$3.39±0.31^b$	-
Iodine value (mgKOH/g)	$38.14±2.62^a$	$22.81±0.23^b$	Max. 115
FFA %	$3.62±0.02^a$	$1.84±.04^a$	-
Flash point ^{0}C	$221.67±2.52^a$	$350.00±2.00^b$	Min. 100
Moisture %	$0.28±0.01^a$	$0.14±.01^b$	Max. 0.1
Ash %	$0.14±0.03^a$	$0.01±.00^b$	Max. 0.02
Colour	Tawny ^{a}	Brown ^{a}	-

ab: Significance different P< 0.05, aa: No significant, SNI: standard national Indonesia

Physic-chemical Properties of Palm kernel and Coconut Oils

From the below Table 3 these results showed significant differences (P<0.05) of the palm and coconut oils between six physic-chemical parameters. Density of coconut was 0.92±.010, palm kernel was 0.91±.01. From these results the density of coconut oil is lower than density of palm kernel oil. These results disagree with Ved and Padam, (2013).This different due to climate and temperature. The saponification of coconut oil was 231.79±1.90 and palm oil was 215.74±1.29, this result showed that saponification of coconut oil is higher than palm oil. These results shows that saponification is obtained from coconut and palm kernel oils is agrees with values for most vegetable oils ranging from 188 - 253 mgKOH/g Oluba et al., (2008), Atasie and Akinhanmi, (2009).This different may due to genotype and molecular weight.The iodine value of coconut oil was 15.91±.22 and palm kernel oil was 22.81±0.23. From this result showed that iodine value of cocont oil is lower than palm kernel oil. These results showed that disagree with Olyni et al., (2014), this different may due to environment, climate and soil. Also indicate to palm kernel oil has high unsaturation fatty acid percent.The peroxide value of coconut oil obtained from these results was 2.57±.15 and palm kernel oil was 3.39±0.31, these results showed

that palm kernel oil has higher peroxide value than coconut oil. These results disagree with Olyni et al., (2014), causes to high temperature during extraction, climate and rainfall. This is indicating to high level of rancidity of palm kernel oil. The FFA of coconut oil obtained from results was 0.40±.01 and palm kernel was 1.84±.04, from these results showed that FFA value of palm kernel is higher than coconut oil. The FFA of coconut oil disagrees with Olyni et al., (2014), and palm kernel FFA values agree with Olyni et al., (2014). The high FFA value of palm kernel oil indicate to highly acidic than palm kernel oil. The color of coconut oil obtained from results was yellow cloudy and palm kernel was brown. Color of oils is most probably May due to pigments content and could be removed by bleaching. However, the color of the oils is not an important factor in end use applications except in some cases where bright color is a prime consideration such as in pigmented coatings. The viscosity of palm kernel oil was 40.67±2.08 and coconut oil was 25.67±.58, this result showed that viscosity of palm kernel oil is higher than coconut oil. The viscosity of coconut oil disagrees with Mansor et al., (2012) and not matches with composition of coconut seed (protein and fats percent), this different may due to temperature, dry seeds and extraction method.

Table 3: Physic-chemical Properties of Palm kernel and Coconut Oils

Parameters	Values		
	Palm kernel oil	Coconut oil	SNI
Density 25^0C (g/cm³)	0.91±.01[a]	0.92±.01 [a]	0.87 – 091
viscosity 27^0C (mm^2/s)	40.67±2.08[a]	25.67±.58 [b]	Max. 36
Saponification value (mgKOH/g)	215.74±1.29[a]	231.79±1.90 [b]	180 – 265
Peroxide value (mgKOH/g)	3.39±0.31[a]	2.57±.15[b]	-
Iodine value (mgKOH/g)	22.81±0.23 [a]	15.91±.22 [b]	Max. 115
FFA %	1.84±.04 [a]	0.40±.01 [a]	-
Flash point ^{0}C	350.00±2.00[a]	276.00±2.00[b]	Min. 100
Moisture %	0.14±.01[a]	.12±.01 [b]	Max. 0.1
Ash %	0.01±.00[a]	.02±.01 [a]	Max. 0.02
Colour	Brown [a]	yellow cloudy [a]	-

ab: Significance different P< 0.05, aa: No significant, SNI: standard national Indonesia

Physic-chemical Properties of Jatropha and Coconut Oils

From the below Table 4 these results showed significant differences (P<0.05) of the Jatropha and coconut between seven physic-chemical parameters. Density of Jatropha was 0.92±.01, coconut was 0.92±.01. From these results the density of Jatropha oil agrees with Raja et al.,(2011), and disagree with Ved and Padam, (2013).This different due to climate, air humidity and temperature. The saponification of Jatropha oil was 177.30±0.89 and coconut oil was 231.79±1.90, from these results showed that saponification of coconut oil is higher than Jatropha oil. This results shows that saponification is obtained from coconut oil is agrees with values for most vegetable oils ranging from 188 - 253 mgKOH/g Oluba et al., (2008). Atasie and Akinhanmi, (2009). This different due to genotype and molecular weight, also indicates that has potential application in the production of biodiesel, soap and shampoos. The iodine value of Jatropha oil was 38.14±2.62 and coconut oil was 15.91±.22. From this result showed that iodine value of Jatropha oil is higher than coconut oil. These results showed that disagree with Olyni et al., (2014) and Raja et al., (2011), this different due to environment, climate and soil. Also indicate to Jatropha oil has high unsaturation fatty acid percent. The peroxide value of Jatropha oil was 5.70±0.17 and coconut oil was 2.57±.15, these results showed that Jatropha oil has higher peroxide value than coconut oil. This result disagrees with Olyni et al., (2014), causes to high temperature during extraction, climate and rainfall. This is indicating to high level of rancidity of Jatropha oil.The observed tawny and yellow cloudy. Color of the oils is most probably May due to the extraction process and could be removed by bleaching. However, the color of the oils is not an important factor in end use applications except in some cases where bright color is a prime consideration such as in pigmented coatings. The FFA of Jatropha oil was 3.62±0.02 and coconut was 0.40±.01, from these results showed that FFA value of Jatropha is higher than coconut oil. The FFA of Jatropha oil agrees with Nzikouet al., (2009), and coconut FFA value disagrees with Olyni et al., (2014). This is different may due to air humidity, climate and genotype. The high FFA value of Jatropha oil indicate to highly acidic than coconut oil. From these results obtained the viscosity of Jatropha oil was 28.33±0.58 and coconut oil was 25.67±.58, this result showed that viscosity of Jatropha oil is higher than coconut oil. The viscosity of coconut oil disagrees with 1 Mansor et al., (2012) and not matches with composition of coconut seed (protein and fats percent), this different may due to temperature, dry seeds and extraction method.

Table 4: Physic-chemical Properties of Jatropha and Coconut Oils

Parameters	Values		
	Jatropha oil	Coconut oil	SNI
Density 25^0C (g/cm³)	0.92±.01[a]	0.92±.01 [a]	0.87 – 091
viscosity 27^0C (mm^2/s)	28.33±0.58 [a]	25.67±.58 [b]	Max. 36
Saponification value (mgKOH/g)	177.30±0.89 [a]	231.79±1.90 [b]	180 – 265
Peroxide value (mgKOH/g)	5.70±0.17 [a]	2.57±.15[b]	-
Iodine value (mgKOH/g)	38.14±2.62 [a]	15.91±.22 [b]	Max. 115
FFA %	3.62±0.02 [a]	0.40±.01 [a]	-
Flash point ^{0}C	221.67±2.52 [a]	276.00±2.00[b]	Min. 100
Moisture %	0.28±0.01 [a]	.12±.01 [b]	Max. 0.1
Ash %	0.14±0.03[a]	.02±.01 [a]	Max. 0.02
Colour	Tawny [a]	yellow cloudy [a]	-

ab: Significance different P< 0.0, aa: No significant, SNI: standard national Indonesia

Fatty Acid Composition Test

The fatty acid composition of Jatropha, palm kernel and coconut oils are shown in Table 5, 6, 7. The major fatty acid in Jatropha oil 9- Octadecadienoic acid was 41.79percent, palm kernel oil was 16.74percent, and coconut oil was 9.06percent, palmitic acid of Jatropha oil was16.08percent, palm kernel oil was 9.37percent, and coconut oil was 9.90percent, Lauric acid of Jatropha oil was 5.77percent, palm kernel was 40.02percent, and coconut oil was 41.12percent, respectively. The result of palmitic and lauric acids of Jatropha oil showed that disagree with Ugbogu et al., (2014), palm kernel oil showed that disagree with Katsriet al., (2013), and coconut oil showed that disagree with Chowdhury et al., (2007). This different of Fatty acids composition amount of Jatropha, palm kernel and coconut oils may due to oxidation of palm and coconut oils during extraction process, climate, and nature of structure fatty acids.

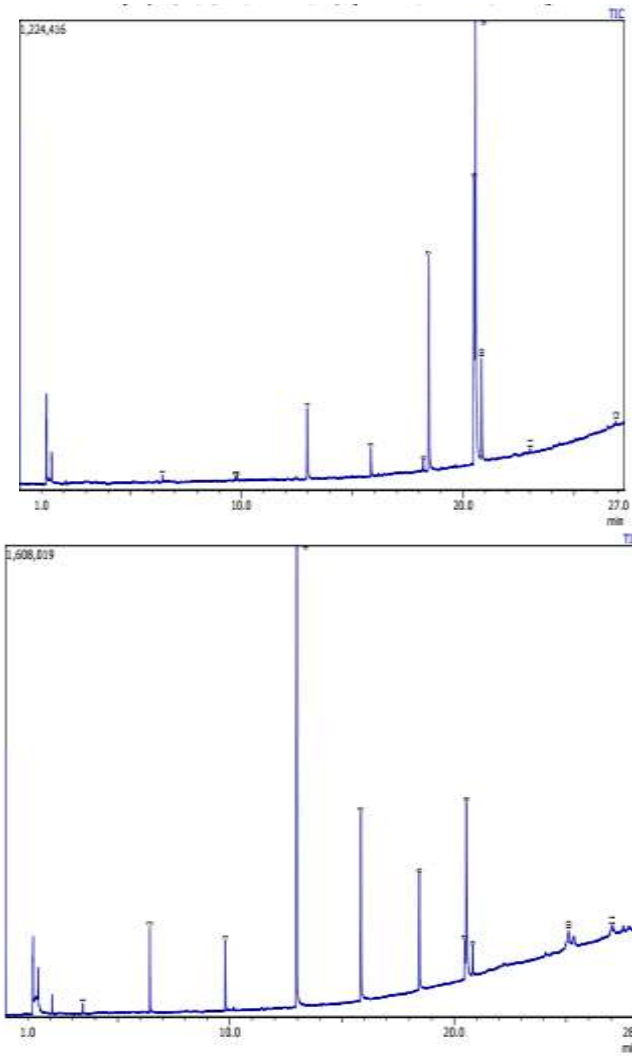

Figure1: Fatty Acids Composition of Jatropha Oil Figure2: Fatty Acids Composition of Palm kernel oil

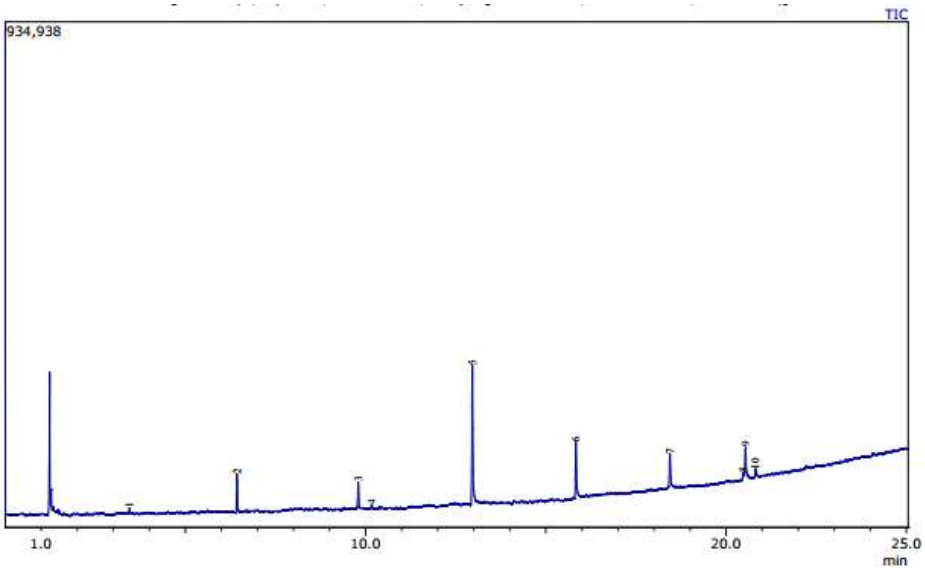

Figure 3: Fatty Acids Composition of Coconut Oil

Table 5: Fatty Acids Composition of Jatropha Oil

Name	A/H	Area% (Value)
Octanoic acid (Caprylic acid)	1.66	0.39
9-Hexadecenoic acid	1.81	0.62
Decanoic acid (Capric acid)	1.76	0.30
Dodecanioc acid (Lauric acid)	2.39	5.77
Tetradecanoic acid (Margaric acid)	2.18	2.12
Hexadecanoic acid (Palmitic acid)	2.18	16.08
9-12- Octadecadienoic acid	2.47	24.39
9- Octadecadienoic acid	2.75	41.79
Octadecanoic acid	2.29	7.96
Cyclohexailoxane	1.45	0.19
Tetracosanoic acid	1.67	0.19
Elcosanoic acid (Arachidic acid)	1.87	0.20

Table 6: Fatty Acids Composition of Palm kernel Oil

Name	A/H	Area% (Value)
Octanoic acid (Caprylic acid)	1.67	5.31
Hexanoic acid (Caproic acid)	1.33	0.47
Decanoic acid (Capric acid)	1.75	4.59
Dodecanioc acid (Lauric acid)	2.34	40.02
Tetradecanoic acid (Margaric acid)	2.20	15.46
Hexadecanoic acid (Palmitic acid)	2.17	9.37
9-12- Octadecadienoic acid	2.09	2.99
9- Octadecenoic acid	2.11	16.74
Octadecanoic acid	1.98	2.09
Glycerol tricaprylate	4.37	1.88
Glycerol tricaprylate	5.56	1.09

Table 7: Fatty Acids Composition of Coconut Oil

Name	A/H	Area% (Value)
Octanoic acid (Caprylic acid)	1.75	9.71
Hexanoic acid (Caproic acid)	1.28	0.93
Decanoic acid (Capric acid)	1.76	6.46
Dodecanioc acid (Lauric acid)	2.07	41.12
Tetradecanoic acid (Margaric acid)	2.19	17.30
Hexadecanoic acid (Palmitic acid)	2.14	9.90
9-12- Octadecadienoic acid	2.24	2.16
9- Octadecadienoic acid	2.11	9.06
Octadecanoic acid	2.15	2.50
2- Dodecenal	1.72	0.85

From these results showed that in Table 2, 3, and 4 to select the best oil was compared physical and chemical properties of Jatropha, palm kernel, and coconut oils with Indonesian National Standard of crude vegetables oils for biodiesel, (2015). As recommended by SNI, (2015) guidelines the allowable value of saponification 180-265 mg KOH/g, Iodine Max 115 mg KOH/g, Density 0.870- 0.910 g/cm³, flash point min 100 ^{0}C, water content max 0.1 %, ash content max 0.02%, ;According to the standards of SNI, (2015) the results showed that the Saponification of Jatropha oil 177.30±0.89 Palm kernel oil 215.74±1.29 coconut oil 231.79±1.90, Iodine of Jatropha oil 38.14±2.62 Palm kernel oil 22.81±0.23 coconut oil 15.91±.22, Density of Jatropha oil 0.92±.01 Palm kernel oil 0.91±0.00 coconut oil 0.92±0.00, flash point of Jatropha oil 221.67±2.52 Palm kernel oil350.00±2.00 coconut oil276.00±2.00, moisture of Jatropha oil 0.28±0.01 Palm kernel oil 0.14±.01 coconut oil 0.12±.01, ash of Jatropha oil 0.14±0.03 Palm kernel oil 0.01±.00 coconut oil 0.02±.01, respectively. In these results Saponification, moisture, ash, and density of Jatropha oil and density of coconut oil showed significant differences with the standards of SNI, and Saponification, flash point, iodine, moisture, ash of coconut oil and Saponification, flash point, iodine, moisture, ash and density of palm kernel oil agree with SNI standard (2015). These results showed that the palm kernel and coconut oils its better than Jatropha oil. These results agree with Olaniyi et al. (2014).

IV. Conclusion

This study has established that palm kernel and coconut oils are containing good physical and chemical properties for biodiesel than Jatropha oil. Palm kernel oil has high amount physical and chemical properties which are more suitable to be processed as raw materials for biodiesel than coconut and Jatropha oils. That it has good oil yield, cheaper and has high amount physical and chemical properties agree with Indonesian National Standards. Make it stand head and shoulders high above its contemporary oils such as coconut and Jatropha oils.

Acknowledgments

We express our thanks to UniversitasPadjadjaran for funding and support this project. We thank Department of Chemistry, UniversitasPendidikan, Also our thanks to the laboratory staff, Faculty of Agro-industrial Technology, University of Padjadjaran.

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Ibrahimaldaw Ibrahim" Study on Physico-Chemical Characteristics ofSome Plant Oils for Raw Materials of Biodiesel" International Journal of Engineering Science Invention (IJESI), Vol. 08, No.10, 2019, PP 66-73