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Physicochemical properties of palm olein based on cloud point value

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ABSTRACT

Palm olein is processed from the fruit of the oil palm (Elaeis guineensis) and used as cooking oil. Olein is widely used for frying in many countries. Therefore, the objective of this study was to research the physicochemical properties of palm olein based on cloud point value and compare the result with PORAM (The Palm Oil Refiners Association of Malaysia) standard and SNI 7709:2019 . The iodine values (IV), peroxide values (PV), free fatty acid (FFA) are often considered to be major significance indexes for the assessment of quality and stability of oils. There were seven samples in total, based on CP value (CP 7.2, CP 7.6, CP 8.0, CP 8.4, CP 8.8, CP 9.2, and CP 9.6). Quality characteristics iodine values (IV), peroxide values (PV), free fatty acid (FFA) of RBD palm olein were measured. Cloud point is related to iodine value. The higher IV, the lower will be the CP. CP is related to the unsaturation level of olein, the more unsaturated the olein, CP will be lower. CP is unrelated with PV and FFA value which the increase CP value has no effect on the PV and FFA value. The physicochemical properties (IV, PV, FFA) of olein CP 7.2, CP 7.6, CP 8.0, CP 8.4, CP 8.8, CP 9.2, and CP 9.6 is fulfil PORAM standard and SNI 7709:2019.

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1. Introduction

The demand and consumption of vegetable oils worldwide, as well as their production through extraction techniques that have been increasingly used in the past century due to an increase in both supply and demand, a rising number of people around the world with access to more effective technology and equipment, are important parts of humans diets. Crude oils are typically refined to remove the majority of these undesirable components in order to produce a stable product with the desired color and flavor, with the least amount of damage to the desirable components, and with the least amount of oil loss. Refined oil is typically colorless, odorless, and rancidity-resistant. Degumming, neutralization, bleaching, and deodorization are often included in the classical refining process of crude vegetable oils. However, a lot of the micronutrients and antioxidants, such polyphenols, tocopherols, sterols, and carotenoids, are lost during these processes, which significantly lowers the nutritional content and quality of vegetable oils (Mohdaly et al., 2017).

Soybean oil, maize oil, safflower oil, rice bran oil, grapeseed oil, olive oil, sunflower oil, peanut oil, palm oil, fish oil, and canola oil are common edible oils found in stores for cooking (Teh et al., 2020). Due to its affordable pricing when compared to other edible oils, palm olein has recently risen to the position of the second most popular dietary oil worldwide (Imoisi et al., 2020).

Crude palm oil (CPO), crude palm kernel oil (CPKO), refined, bleached, and deodorized (RBD) palm oil (RBDPO), and RBD palm olein (RBDPO) are some of the palm oil products that are among the most traded in the world (Roslan et al., 2023). The complicated physicochemical behavior of edible oils is attributed to the large range of triacylglycerols (TAGs) that have various fatty acid (FA) compositions (Cremer et al., 2023). The mesocarp of the fruit oil palm (*Elaeis guineensis* Jacq) is pressed to produce palm oil. Saturated and unsaturated fatty acids are present in palm oil in about equal amounts. The two main fatty acids are palmitic and oleic, with linoleic and trace quantities of linolenic acid. This oil is oxidation-resistant due to the high concentration of saturated fatty acids and the low concentration of linolenic acid. A liquid fraction called palm olein is produced during the fractionation of palm oil, which entails crystallization at certain temperatures and filtering to remove crystals. Palm olein differs from palm oil in that it contains more oleic acid than palmitic acid (Paunović et al., 2020).

A combination of high-melting and low-melting triglycerides can be found in palm oil. Higher melting triglycerides will crystallize into a solid portion called stearin at room temperature, while lower melting triglycerides will stay in a liquid state called olein (Zaliha et al., 2004). The iodine values (IV), acid values (AV), and peroxide values (PV) are frequently regarded as the primary significant indices for evaluating the stability and quality of oils (Geng et al., 2023). IV is a significant indicator of a triacylglycerol oil's degree of unsaturation. One of the most used quality indicators for tracking lipid oxidation is PV. The breakdown of triacylglycerols into free fatty acids is commonly measured by AV, which has an adverse effect (Al-Bachir & Koudsi, 2021). There are many accepted laboratory techniques for evaluating the oxidative stabilities of oils according to their free fatty acid (FFA) content, cloud point, iodine value, and peroxide value (Teh et al., 2020).

The required quality characteristics, such as moisture, contaminants, free fatty acids, slip melting point, peroxide value, and iodine value, as stated in the Palm Oil Refinery Association of Malaysia (PORAM) standard (Ahmad Bustamam et al., 2022). As Sni 7709-2019, the required parameters is smell and taste, color, water content, free fatty acid, peroxide value, pelican oil, vitamin A and metal contamination (Pb, Cd, Hg, As and Sn) (Juniarto & Isnasia, 2021).

The objective of this study was to research the physicochemical properties (FFA, IV and PV) of palm olein based on cloud point value and compare the result with PORAM (The Palm Oil Refiners Association of Malaysia) standard and SNI 7709:2019 .

2. Methods

Oil samples is RBD Palm Olein were compared by standard analytical methods for determination of the cloud point (CP), Free Fatty Acid (FFA), iodine value (IV) and peroxide value (PV). There were seven samples in total based on CP value: CP 7.2, CP 7.6, CP 8.0, CP 8.4, CP 8.8, CP 9.2, and CP 9.6. This research aims to see the effect of CP values on FFA, IV and PV.

2.1 Cloud point (CP)

Oil sample of 60-75 g was filtered using Whatman No.1 filter paper and heated for 5 min at 130°C for foreign matter and moisture removal. The sample (45 ml) was then put in a Beatson bottle, cooled (using water bath) and stirred until it reached 10°C. More vigorous stirring was applied below 10°C when near to the expected cloud point, to avoid supercooling and fat(Mohd Hassim et al., 2021).

2.2 Iodine value by Wij's method (IV)

As the iodine absorbed by 100 g of the sample, it was characterized as the iodine content in grams. IVs were always used to test the unsaturation of oils or fats. For this determination, the AOCS Cd 1–25 technique was applied (Geng et al., 2023). Triplicate measurements were carried out for each sample.

2.3 Free Fatty Acid (FFA)

The FFA value was determined according to the American Oil Chemists Society (AOCS) Official Method Ca 5a-40 using titration method. Oil sample (20 g) was dissolved in 50 ml isopropanol and 2 ml phenolphthalein indicator solution. 0.1 M sodium hydroxide is titrated to the mixture until first permanent colour of pink appeared. This colour must remain for at least 30 s. The FFA was calculated based on the percentage of palmitic acid (Mohd Hassim et al., 2021). Triplicate measurements were carried out for each sample.

2.4 Peroxide Value (PV)

POV, which is measured in milli-equivalents of active oxygen per kilogram of oil and is based on the iodine that potassium iodide releases, is defined. POV operated within the guidelines provided in the AOCS Cd 8–53 procedure (Geng et al., 2023). Triplicate measurements were carried out for each sample.

3. Results and Discussion

3.1 Result

Free fatty acid

Figure 1 shows the free fatty acid value of palm olein CP 7.2, CP 7.6, CP 8.0, CP 8.4, CP 8.8, CP 9.2, and CP 9.6. The FFA value is CP 7.2 (0.055%), CP 7.6 (0.063%), CP 8.0 (0.060%), CP 8.4 (0.057%), CP 8.8 (0.065%), CP 9.2 (0.062%), and CP 9.6 (0.062%). The graphic does not show linier line, meaning the cloud point is unrelated with FFA value which the increase cloud point value has no impact of the FFA value.

The production of free fatty acids in oils is facilitated by the hydrolysis of triglycerides. This has the potential to produce substances that are susceptible to oxidative reactions. Triglycerides are hydrolyzed into fatty acids and glycerol by an enzyme class called lipase. One glycerol molecule and three fatty acid molecules bound together by ester bonds make up triglycerides, the most prevalent kind of lipids (Imoisi et al., 2020).

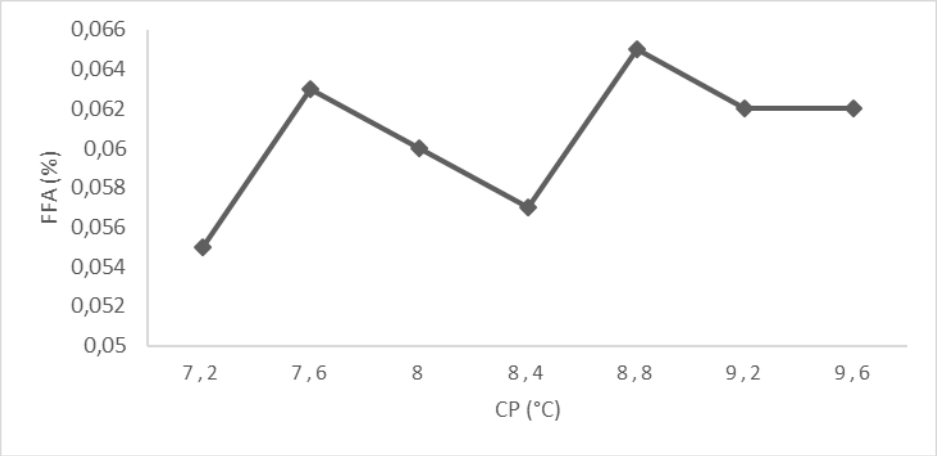

Figure 1. CP and FFA palm olein

Iodine value

Figure 2 shows the iodine values of palm olein CP 7.2, CP 7.6, CP 8.0, CP 8.4, CP 8.8, CP 9.2, and CP 9.6 . The result of iodine value is CP 7.2 (58.92 g/100 g), CP 7.6 (58.58 g/100 g), CP 8.0 (58.39 g/100 g), CP 8.4 (57.56 g/100 g), CP 8.8 (57.27 g/100 g), CP 9.2 (57.12 g/100 g), and CP 9.6 (56.67 g/100 g). IV decreases when CP temperature is higher, indicating the unsaturation level of olein is lower and otherwise. Cloud point is related to the iodine value of the olein.

Iodine value measures the degree of unsaturation of oils and fats as determined by various standard methods such as the Wijs (Imoisi et al., 2020). The more high IV value of the olein, cloud point will lower. Iodine value is related with the unsaturation level of the olein (Kuriyama et al., 2011).

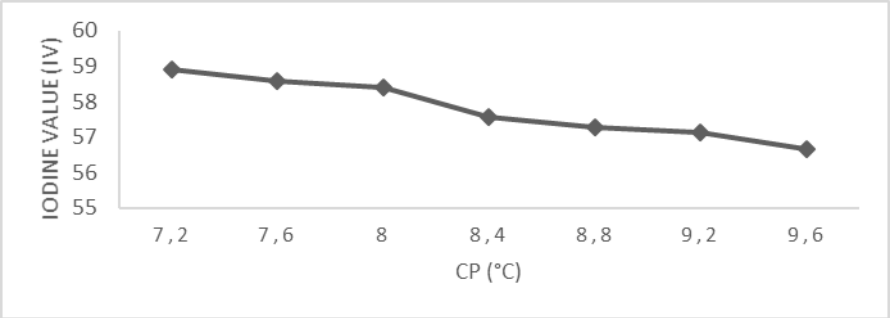

Figure 2. CP and IV RBD Palm Olein

Peroxide Value

Figure 3 shows the peroxide values of palm olein CP 7.2, CP 7.6, CP 8.0, CP 8.4, CP 8.8, CP 9.2, and CP 9.6. PV result is CP 7.2 (0.42 Meq O2/kg), CP 7.6 (0.46 42 Meq O2/kg), CP 8.0 (0.3942 Meq O2/kg), CP 8.4 (0.3742 Meq O2/kg), CP 8.8 (0.3642 Meq O2/kg), CP 9.2 (0.4442 Meq O2/kg), and CP 9.6 (0.3742 Meq O2/kg). Cloud point is unrelated with peroxide value, which the increase of cloud point value has no impact on the peroxide value. Peroxide value is almost consistent in range 0.3 – 0.46.

A measure of the main products of oil oxidation is the peroxide value (Yang et al., 2020). Peroxides being unstable at elevated temperatures tend to decompose to form secondary oxidation products such as aldehydes and ketones. The thermal instability of peroxides in palm olein may be related to its fatty acid composition and their degrees of unsaturation (Imoisi et al., 2020).

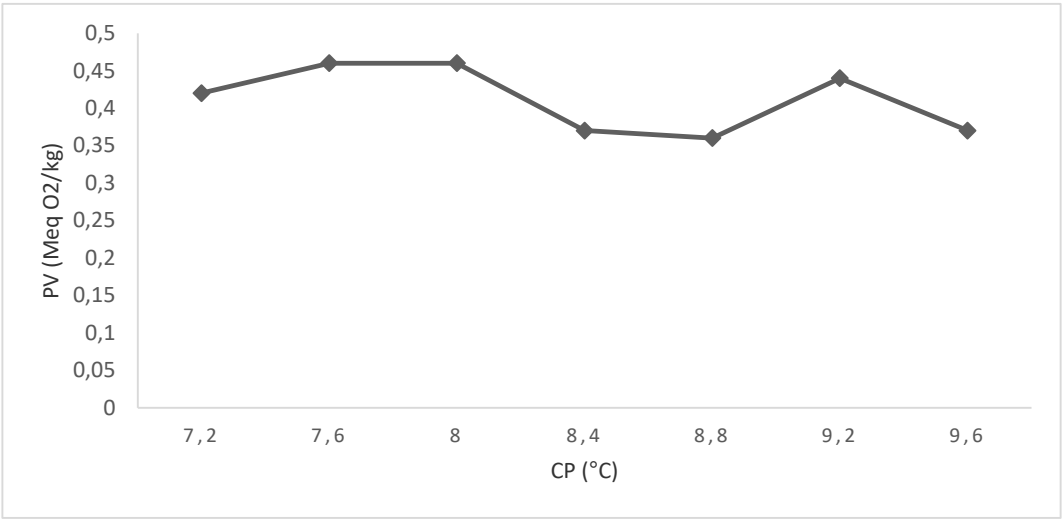

Figure 3. CP and PV RBD palm olein

3.2 Discussion

From the figure, it clearly showed that the quality characteristic of palm olein samples from different CP, referring FFA, IV dan PV parameters were within the requirement as specified in Table 1 and Table 2.

Table 1 shows PORAM Standard Specification for RBD Palm Olein. As PORAM specification (Chong, 2012), FFA standard is 0.1% max which the research result is CP 7.2 (0.055%), CP 7.6 (0.063%), CP 8.0 (0.060%), CP 8.4 (0.057%), CP 8.8 (0.065%), CP 9.2 (0.062%), and CP 9.6 (0.062%). FFA Olein for all samples is fulfil PORAM (Palm Oil Refinery Association of Malaysia) standard which FFA result is < 0.1%. Poram standard specification for IV is 56 min, which the research result is CP 7.2 (58.92 g/100 g), CP 7.6 (58.58 g/100 g), CP 8.0 (58.39 g/100 g), CP 8.4 (57.56 g/100 g), CP 8.8 (57.27 g/100 g), CP 9.2 (57.12 g/100 g), and CP 9.6 (56.67 g/100 g). Meaning that all samples fulfill PORAM specification for IV and FFA value.

Table 1
PORAM standard specification for RBD palm olein

Parameter	Standard
FFA (As Palmitic)	0.1% max
M&I	0.1% max
I.V. (Wijs)	56 min
M.Pt degrees C (AOCS Cc 3-25)	24 max
Colour	3 Red max

Table 2 shows SNI 7709:2019 is a standard regulation for palm cooking oil in Indonesia (BSN, 2019). As SNI 7709:2019 standard, FFA standard is 0.3% max, higher than PORAM standard which is 0.1%. The research result is CP 7.2 (0.055%), CP 7.6 (0.063%), CP 8.0 (0.060%), CP 8.4 (0.057%), CP 8.8 (0.065%), CP 9.2 (0.062%), and CP 9.6 (0.062%). FFA olein for all samples is fulfil SNI 7709:2019 which FFA result is < 0.3%. SNI 7709:2019 standard for PV is 10 Meq O2/kg max, which the research result is is CP 7.2 (0.42 Meq O2/kg), CP 7.6 (0.46 42 Meq O2/kg), CP 8.0 (0.3942 Meq O2/kg), CP 8.4 (0.3742 Meq O2/kg), CP 8.8 (0.3642 Meq O2/kg), CP 9.2 (0.4442 Meq O2/kg), and CP 9.6 (0.3742 Meq O2/kg). Palm Olein with CP 7.2, CP 7.6, CP 8.0, CP 8.4, CP 8.8, CP 9.2, and CP 9.6 is fulfil SNI 7709:2019 (FFA 0.3% max, PV 10 Meq O2/kg max). Meaning that all samples fulfill SNI 7709:2019 standard for FFA and PV value.

Table 2
Requirements for the quality of palm cooking oil based on SNI 7709:2019

Parameter	Content	Standard
Smell	-	Normal
Flavor	-	Normal
Colour	R/Y	5R/50Y max
Water content and volatile matter (w/w)	%	0.1 max
FFA (as palmitic)	%	0.3 max
Peroxide Value	Meq O2/kg	10[1] max
Vitamin A[2]	IU/g	45[1] min
Pelican oil		Negative
Cd	mg/kg	0.1 max
Pb	mg/kg	0.1 max
Sn	mg/kg	40.0/250.0[3] max
Hg	mg/kg	0.05 max
As	mg/kg	0.1 max
Note:		
[1]sample at factory		
[2]Vitamin A (total) is total Vit A & pro Vit A (karoten) which equivalent with Vit A		
[3]sample on can		

4. Conclusion

RBD Palm Olein (cooking oil) with CP variations was tested with parameters of free fatty acid, iodine value and peroxide value to determine the relationship. This research was conducted to test the FFA, IV and PV levels of palm cooking oil with CP variations. showed that cloud point is related with iodine value of palm olein. Iodine value is showing unsaturated oil in olein. The higher IV, the CP will be lower. CP is unrelated with PV and FFA value which the increase CP value has no effect on the PV and FFA value. Olein with CP 7.2, CP 7.6, CP 8.0, CP 8.4, CP 8.8, CP 9.2, and CP 9.6 is fulfil PORAM standard (FFA 0.1% max, IV 56 min) and SNI 7709:2019(FFA 0.3% max, PV 10 Meq O2/kg max) which mean that the cloud point <9.6 have good quality to used as cooking oil. In the future, testing can be carried out for all quality-related parameters

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