

Quality analysis of cooking oil (RBD Palm Olein) based on PORAM standard specifications

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ABSTRACT

RBD Palm olein is extracted and used as cooking oil from fruit of the oil palm (*Elaeis guineensis*). RBD Palm Olein is widely used for cooking oil in many countries. Quality is an important and useful characteristic of edible oil commodities and their transactions from a business aspect. The purpose of this study is to evaluate cooking oil (RBD palm olein) quality using the standards set out by PORAM (The Palm Oil Refiners Association of Malaysia). Determining the necessary quality standards, such as moisture and impurities (M&I), free fatty acids (FFA), slip melting point (SMP), iodine value (IV), and color, as stated in the PORAM specification. There were six samples in total and the quality analysis result is compared with the PORAM Specification. All samples are fulfilled PORAM specifications.

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INTRODUCTION

Indonesia is the world's largest palm oil producing country (Ramadhani et al., 2022). Vegetable oils are a type of lipids derived from a variety of plant materials, such as cereal grains, fruits, seeds, and nuts. (Tan et al., 2022). Originally known as an ornamental plant, the oil palm (*Elaeis guineensis*) has developed into Indonesia's most important commodity crop. In the palm oil industry, crude palm oil refining is a crucial step (Yung et al., 2020). After passing through many fractionation procedures, the precious oil extracted from oil palm mesocarp has unique physical and chemical qualities and semisolid at room temperature. Additionally, it has unique fatty acid and triacylglycerol (TAG) profile characteristics that make it appropriate for a wide range of dietary applications. The palm oil is first fractionated to provide two distinct fractions: palm stearin (solid form) and palm olein (liquid form) (Ahmad Bustamam et al., 2022). It is commonly known that refined palm oil, or processed palm oil, is produced when crude palm oil is subjected to a temperature of 270°C for degumming, bleaching, and deodorization before being fractionated to produce the liquid fraction known as palm olein (Loganathan et al., 2020c).

In all, Indonesia and Malaysia generate 85% of the palm oil used worldwide, smallholders, state-owned businesses, and private businesses all benefit greatly economically from palm oil.

Indonesia grows oil palm on 14 million hectares (ha); the country exported 21 billion and 23 billion dollars' worth of palm oil in 2017 and 2018, respectively (Purnomo et al., 2020). Furthermore, because both Indonesia and Malaysia export the product, palm oil is significant to both economies (Arsyad et al., 2020). The high value and significant significance that palm oil represents in the Indonesian economy make it a commodity that could increase the nation's foreign exchange earnings (Ramadan* & Hasmarini, 2023).

The palm oil derivatives that are usually in great demand worldwide include Refined Bleached Deodorized (RBD) palm olein, Palm Fatty Acid Distillate (PFAD), and Crude Palm Oil (CPO), which is the main product (Arsyad et al., 2020). RBD palm olein which are mostly used as cooking oil and in margarine, confections, non-dairy creamer, shortening, and other applications. It is reasonable to anticipate that customers and their end users would seek more quality improvement as product development and improvement goes at a quick pace. Quality is an important and useful characteristic of edible oil commodities and their transactions from a business aspect (Roslan et al., 2023).

Indonesian palm oil exports have experienced ups and downs that are determined by quality. Indonesian palm oil has been returned because it was contaminated and did not meet standards. Of course, this is a threat to the trade in Indonesian palm oil. In addition, the competition for palm oil exports with Malaysia means that Indonesian CPO and derivative must have quality and characteristics that meet international trade requirements (Arsyad et al., 2020). Concentrated phosphoric acid is used as a pre-treatment for CPO throughout the refining process. This is followed by deodorization, bleaching with earth or clay, and removal of leftover bleaching earth. Refining palm oil generally involves two steps: chemical and physical. The methods by which the FFA are eliminated vary (Yung et al., 2020).

By using caustic soda to neutralize the FFA, chemical refining produces soapstock, which is then processed with diluted sulfuric acid to produce palm acid oil as a by product. FFA are taken out of the oil as PFAD during the deodourization stage of physical refining. The results of chemical and physical refinement have been referred to using different nomenclature (Gordon, 1997). RBD palm oil is the end result of physical refining, whereas neutralized, bleached, and deodorized palm oil is the refined palm oil derived from chemical refining. Because of its various benefits, physical refining is recommended, especially its reduced operating costs and improved refining efficiency (Yung et al., 2020).

Cooking oil is oil that is cooked with food or used as a heat conductor in cooking food and contains vitamins A, D, E, and fat for cell formation and body defense, so cooking oil is beneficial for health (Yeniza & Asmara, 2020). Cooking oil is frequently used to prepare meals for everyday diets (Loganathan et al., 2020a). One of the most popular options for cooking oil, palm olein is utilized frequently across the world (Wong et al., 2019). During frying, a number of chemical events, including hydrolysis, oxidation, oxidative polymerization, and thermal polymerization, take place in the oil (Abd Razak et al., 2021). The quantity of fatty acids, both unsaturated and saturated in palm oil is approximately equal, indicating that the fatty acid content of the oil is balanced. The main component acids are oleic acid (39-40%), palmitic acid (44-45%), and linoleic acid (10-11%), contains a very little quantity of linolenic acid (de ALMEIDA et al., 2019). Previous palm olein quality testing obtained FFA results of 0.02 - 0.07, M&I 0.01 - 0.02, IV 54.33 - 59.14, melting point 19.8 - 23.0, saponification number 197.1 - 198.2, cloud point 8.5 - 11.5 (Hasibuan, 2012).

One of the most common pollutants in RBD palm olein is moisture. Because a high moisture level would impact hydrolytic stability, it is imperative to make sure palm olein moisture content is below the allowed range (Chong, 2012). Inadequate processing of some palm oil products results in a significant quantity of moisture and contaminants, which could accelerate the microorganism's activity (Dongho et al., 2016). Since FFA is correlated with the edible oils' economic worth, it is an important indicator of palm olein quality in addition to moisture content.

In general, FFA gets formed when oil and water react during storage, and a high FFA content indicates low palm olein quality (Roslan et al., 2023).

The IV determines the double bonds in palm olein or the degree of unsaturation (Peamaroon et al., 2021), which represents the oils' susceptibility to oxidation (Tarmizi et al., 2008). A common use of the melting point is to examine the melting and solidification characteristics of oil samples, where the solidified oil's temperature changes to a fluid state and flows into an open capillary tube (Roslan et al., 2023).

RESEARCH METHOD

Analyses of quality

Quality parameter tests were performed on RBD palm olein samples (oil specification CP 8 and CP 10); colour, M&I, FFA, iodine value, and slip melting point. The sources of the analytical techniques performed differ according to which is most suitable for olein samples. Every analysis was carried out three times.

Moisture and Impurity (M & I)

The moisture content of the palm olein sample was measured using a volumetric titration Karl Fischer moisture analyzer in compliance with ISO 8534:2017. Samples were added to the validated Aqualine® reagent from Fisher Scientific, which has been shown to function with regular water solutions within the necessary range. In compliance with ISO 663:2017 the impurities were ascertained by use of the oven technique. After filtering the sample using Whatman Paper No. 4, petroleum ether was used to wash it many times. Subsequently, the filter paper containing the filtrate was baked for two hours at $103^{\circ}\text{C} \pm 1^{\circ}\text{C}$. A percentage was computed based on the measured residue weight (Ahmad Bustamam et al., 2022).

Iodine value (IV)

The quantity of iodine absorbed by 100 g of the sample was the definition of the iodine content in grams. IVs were always employed to check if fats or oils were unsaturated. The AOCS Cd 1-25 approach was used to make this determination (Geng et al., 2023).

A flask was filled with 0.2 g of oil mass, followed by the addition of 25 ml of Wijs reagent and 15 ml of carbon tetrachloride solution (CCl_4). Following a gentle shake and an hour in the dark, 20 ml of the potassium iodide (KI) aqueous solution (10g/100ml), 15 ml of distilled water, and the tightly closed vial was filled with five drops of 1% starch solution paste. After titrating the flask's solution with a 0.1 N sodium thiosulfate solution ($\text{Na}_2\text{S}_2\text{O}_3$), the volume V1 of sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) that was needed to make the flask's solution blue was measured. The blank test was also utilized in this titration, and the volume V0 of sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) was recorded. Utilizing the formula, the iodine value (IV) expressed in iodine was computed (Houketchang Ndomou et al., 2023).

$$\text{IV} = \frac{(\text{V}_0 - \text{V}_1) \times 12.69 \times \text{T}}{\text{M}}$$

Note:

V₀ (ml): Volume of $\text{Na}_2\text{S}_2\text{O}_3$ solution for the blank; V₁ (ml): Volume of $\text{Na}_2\text{S}_2\text{O}_3$ solution for the sample; T: Titer of $\text{Na}_2\text{S}_2\text{O}_3$ solution that used; M (g): Mass of the sample.

Free Fatty Acid (FFA)

Using the titration method, AOCS Official Method Ca 5a-40 was used to calculate the FFA value. A 20 g oil sample was dissolved in a mixture of 2 ml phenolphthalein indicator and 50 ml isopropanol. 0.1 M sodium hydroxide is added to the mixture and titrated until the first noticeable pink color develops. It needs to maintain this color for a minimum of thirty seconds. The FFA was calculated using the amount of palmitic acid as a base (Mohd Hassim et al., 2021).

Melting Point

Melting point was determined according with AOCS Cc 3-25. The samples that had crystallized were melted fully at 60°C before the determination was made. To get rid of any contaminants, the samples that had already melted were filtered using Whatman no. 41H filter paper. The oil samples were placed into three sterile capillary tubes. In the tubes, the sample grew to a height of around 10 mm. The tubes containing the samples were cooled by pressing their ends against a block of ice until the fat hardened. The tubes and a beaker were stored in a refrigerator between 4 and 10°C for 16 hours.

After taking the tubes out of the fridge, they were fastened to the thermometer using a rubber band. This was done to ensure that the lower ends of the melting point tubes were level with the mercury thermometer bulb. In 400 milliliters of pure distilled water, the thermometer was suspended. The thermometer was submerged up to the immersion mark in the water (Gold et al., 2011). The initial bath temperature was set at 8-10°C below the sample's slip point. A little stream of air was used to stir up the heating source SI Analytics, and heat was given to the bath at a rate of 1°C per minute at first, then reducing to 0.5°C per minute as the slip point got closer. Every tube was heated continuously until the fat column ascended. Each column's rising temperature was recorded, and the average temperature across all tubes was determined. This was described as the melting point for slips (Imoisi et al., 2020).

Colour

AOCS Official Method Cc 13e-92 was followed in measuring the color of samples using a Lovibond Tintometer Model F. Glass cells with route lengths of 1 inch and 5 1/4 in. (13.3 and 2.5 cm) were utilized to hold the test samples. Samples were cooked in an oven at 60 ± 2°C for one hour. Sample was placed within an aliquot glass cell and put inside the cabinet for illumination. Using color racks and a baseline ratio of 1 red (R) and 10 yellow (Y), the lighting cabinet's lid was closed and the sample color was quickly ascertained (Mohd Hassim et al., 2021).

RESULTS AND DISCUSSIONS

The sample is RBD palm olein with oil specification CP 8 (3 samples) and oil specification CP 10 (3 samples). All samples are tested with parameter cloud point, colour, FFA, melting point, IV, and moisture and impurity (M&I).

The result from the examination is shown in Table 1. RBD palm olein testing result. Sample with CP 8 specification showing that all CP results are 8.0. Sample with CP 10 specification showing that all CP results are 9.6, 9.8, and 9.6.

Table 1. RBD palm olein testing result

No. Sample	CP	COLOUR	FFA	M.Pt	IV	M&I
1	8.0	2.1R	0.066%	19.6	58.20	0.062%
2	8.0	2.1R	0.068%	19.6	58.17	0.069%
3	8.0	2.3R	0.067%	19.8	58.26	0.047%
4	9.6	2.5R	0.075%	19.6	56.43	0.043%
5	9.8	2.5R	0.079%	18.6	56.26	0.068%
6	9.6	2.5R	0.075%	19.6	56.48	0.043%

In international trading, PORAM is a reference to know the quality of RBD palm olein, table 2 shows PORAM Standard Specification for RBD palm olein. All samples which tested (samples 1, 2, 3, 4, 5, and 6) show that all samples meet the requirements of PORAM specification. The result obtained is IV > 56, M.Pt <24°C, FFA <0.1%, M&I <0.1%, and colour <3R.

Table 2. 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

Free fatty acid (FFA)

Triglycerides in the oil hydrolyze to produce FFA. Since FFA gives the oil a bad metallic flavor, it is an unwanted component. High FFA levels will eventually cause rancidity, which alters oil nutritional and sensory qualities (Roslan et al., 2023). From the research results the FFA values of samples (Table 1) are still below the maximum limit stated in the specifications.

M&I

Small quantities of moisture may be readily absorbed and maintained by lipids, despite their primary hydrophobic nature. Because it promotes microbial development and lipid breakdown, which raises the FFA concentration, moisture is frequently undesirable. Furthermore, the oil's flavor, aroma, and look may be negatively impacted, which might lower its marketability and client acceptability (Roslan et al., 2023). Tables 1 depict the moisture content obtained from samples. The maximum permissible amount of moisture is 0.1%, it was observed that the moisture content of all samples fulfills the specifications.

Iodine value (IV)

The IV is a halogen absorption derived measure of the relative degree of unsaturation in oil components. Greater unsaturation and increased susceptibility to oxidation are indicated by a higher IV value (Roslan et al., 2023). According to the PORAM standard, the minimal admissible IV for RBD palm olein is 56. According to the results obtained in Table 1, it can be assumed that all samples have good quality in terms of IV since the value is within the specified minimum limit.

Melting point

Based on the data in Table 1, the melting point of the tested palm olein met the requirement specified by PORAM standard with a value of the maximum is 24 °C.

Colour

Color is a frequently used metric to assess the quality of oil. It is often used to determine the cooking oil's quality (Maskan, 2003). Color plays a critical role in indicating compositing, deterioration, quality and purity for goods in the edible oil and fat industry (Patil et al., 2023). Carotene breaks down during refining, producing refined oil with a pale yellow color while retaining other trace amounts of phytonutrients (Loganathan et al., 2020a). Based on the data in Table 1, the colour of the tested palm olein met the requirement specified by PORAM standard with a value of maximum of 3R.

Cloud point

To remove moisture and foreign matter, an oil sample weighing between 60 and 75 grams was heated to 130°C for five minutes and filtered using Whatman No. 1 filter paper. Once the sample (45 ml) was in a Beatson bottle, it was swirled and chilled in a water bath until the temperature reached 10°C. In order to prevent supercooling and fat buildup, more aggressive stirring was used below 10°C when the predicted cloud point approached (Mohd Hassim et al., 2021)

CONCLUSION

In terms of industrial processes, the quality of cooking oil (RBD palm olein) is critical. There are two types of palm oil refining processes: chemical and physical, and they differ in how FFA is eliminated. FFA is taken out of the oil as PFAD during the deodourization stage of physical refining. Physical refining is recommended, especially its reduced operating costs and improved refining efficiency. The quality of all samples was determined through cloud point, moisture and impurities, FFA, IV, colour and SMP. This study showed that cloud point is related to the iodine value of palm olein. All samples which tested show that all samples meet the requirements of PORAM specification. The result obtained is IV > 56, M.Pt <24°C, FFA <0.1%, M&I <0.1%, and colour <3R.

In the palm oil industry, the recommended quality is oil with a minimum specification of CP 10 which in the study showed IV results of 56.23 - 56.48 (fulfil PORAM specification standard 56 min). Cloud point (CP) has a correlation with IV, the lower of CP is the higher IV result which means the better quality of the oil. CP 8 oil has the best quality compared to CP 10 oil.

The implications of the results for the quality of products received by consumers are important and in the global market, characteristics of palm olein are usually based on PORAM specification standards so it must meet quality standards. For further research of product development should be based green economy with the palm oil industry for sustainability.

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