



Refining village cooking oil using whiting as a substitute for sodium hydroxide

Jeanne Maria Tuerah, Sofia Satriani Krisen

Department of Chemistry, Faculty of Mathematics and Natural Sciences, Manado State University, Indonesia

Abstract

Most of the cooking oil circulating in Indonesia comes from coconut oil. The processing process is generally dry (copra) and wet. The wet method is widely used by farmers through a heating process which produces village cooking oil. The kampung cooking oil produced so far is still below the quality standard, so it is easily damaged. To overcome this, purification of the village cooking oil must be carried out. In this study, village cooking oil was purified in 2 stages of the process, namely degumming and neutralization. Then the results of this study were compared with SNI standards. Observations were made on parameters which included: water content, Free Fatty Acid (FFA) content, acid number and peroxide value. Based on the research results, the addition of 0.15% concentration. Whiting in the degumming and neutralization process can reduce the value of the acid number to 0.5 mg NaOH/gr, the peroxide value to 1mgO₂/100g and the free fatty acid content to 0.3%. This means that after the process of refining the kampung cooking oil that was tested met the SNI No 7709-2012 standard, which had been set. However, the water content is still not good because it exceeds the maximum limit of SNI.

Keywords: Village cooking oil, whiting, sodium hydroxide

Introduction

The coconut plant (*Cocos nucifera*) is a plant native to tropical areas, found in many coastal and mountainous areas. This plant is widely cultivated by most farmers in North Sulawesi, because it has many uses. Apart from being consumed fresh, coconut meat can also be processed into valuable food raw materials such as cooking oil (Anonim, 2002; Subagio, 2010)^[18].

The process of processing cooking oil is generally done dry (copra), mostly done on a factory scale and mostly done wet by farmers. Processed by farmers is usually called traditional cooking oil or village cooking oil. This cooking oil is prepared by heating coconut milk juice over medium heat until the oil comes out and separates from the blondo (dregs). Making oil in this way is relatively easy and the equipment used is also relatively simple (Kataren, 2005^[10]; Sutanto & Abriana, 2015)^[21].

The people's processed cooking oil produced so far is still below quality standards. Good cooking oil according to SNI for cooking oil, must be based on the Ministry of Industry. Cooking oil that does not comply with SNI is easily damaged, does not last long, only lasts around 2-3 weeks, has an unpleasant flavor and is not clear. This can be caused by the heating process at high temperatures (100-110°C) the proteins, fats and antioxidants contained will be damaged. Apart from that, free fatty acid levels are still high (Kataren, 2005^[10]; Setiaji, 2005^[17]; Derlean, 2009; Tri *et al.*, 2010^[22]). To overcome this, purification must be carried out.

The main aim of the oil refining process is to remove unpleasant tastes and odors, unattractive colors and extend the shelf life of the oil before consumption or use as raw materials in industry. The strategy that can be applied is to carry out a purification process (neutralization, bleaching and deodorization) (Anonim, 2002; Ana *et al.*, 2015^[1]; Gumus *et al.*, 2020)^[7].

Oil purification through a neutralization process has been widely carried out. Generally, the chemical substance NaOH is used as a neutralization agent, which is a strong alkaline

material (Anonim, 2002; Kataren, 2005^[10]; Setiaji, 2005)^[17]. Several studies have begun to be developed using weak alkalis. Gumus *et al* (2020)^[7] used Ca(OH)₂ 0.15%, MgO 0.5%, Na₂SiO₃ 0.5%, and 0.2% NaOH, to neutralize sunflower oil. By using these ingredients, the free fatty acid content was reduced to 0.05, 0.07, 0.11, and 0.12%, respectively. Previously, Suntoro, *et al* (2016)^[19] in their research found that the addition of Betel Lime Ca(OH)₂ could inhibit damage to Coconut Nira (Gumus *et al.*, 2020^[7]; Meilano, 2017^[12]; Suntoro *et al.*, 2016)^[19].

Betel lime, also known as lime oxide (CaO), is the result of burning or heating raw lime calcium carbonate CaCO₃ at temperatures above 825°C. Calcium carbonate is found in many kimah shells. Kimah clams (*Tridacnidae*) are mollusks, which can also be called giant clams. Betel lime, the result of burning shellfish, is widely used by coastal communities as an ingredient for betel quid (Hariyati *et al.*, 2019^[8]; Mudjiono, 1988^[13]; Rizkevena, 2014)^[15]. The use of chemicals for the neutralization process is not liked by farmers. This research is expected to provide information about the use of whiting in the refining process of village cooking oil.

Material and Methods

The materials used in this research were coconut fruit, phosphoric acid, technical NaOH, technical Na₂CO₃, distilled water, 95% ethyl alcohol, 1% phenolphthalein (PP) indicator in 95% alcohol, potassium hydroxide solution, iso-octane or N-hexane, glacial acetic acid: chloroform 3:2 (v/v), saturated KI (10 gr in 5 ml distilled water), sodium thiosulfate 0.01 N, 1% starch/starch indicator solution. The tools used in this research were agitator, hot plate, stirrer, calico cloth, thermometer, petridish, analytical balance with an accuracy of 0.001 grams, burette, 10 ml measuring flask, Whatman filter paper, centrifuge, measuring flask. Making whiting begins with cleaning clam shells from the coast, then burning them overnight. The results obtained were sieved and a 0.15% solution was made.

Research procedure

1. Water content test

Determination of water content in oil is carried out using the oven method. Dry the beaker in the oven for 15 minutes at 105°C, cool in a desiccator for 15 minutes then weigh the empty glass. Place a 10 gram sample in a beaker and weigh it. Then heat it in the oven for 30 minutes at 105°C. Cool the sample in a desiccator for 15 minutes and weigh the beaker + sample after oven. Calculate the water content (Musyaroh & Hidayat, 2018^[14]; Kristianingrum, 2005^[11]; Ervina *et al.*, 2014).

2. Free fatty acids

Determination of free fatty acid levels. The sample was weighed as much as 10 g and put into a 250 ml Erlenmeyer flask. 50 ml of warm alcohol and 5 drops of phenolphthalein indicator were added to the sample and then titrated with NaOH until the color changed from colorless to pink which did not disappear for 30 minutes (BSN, 2012). Then calculate the % free fatty acids.

3. Acid number

Determination of free fatty acid levels (SNI 7709:2012). The sample was weighed as much as 10 g and put into a 250 ml Erlenmeyer flask. To the sample, add 50 ml of warm alcohol and 5 drops of phenolphthalein indicator and then titrate with NaOH until the color changes from colorless to pink which does not disappear for 30 minutes (BSN, 2012).

4. Peroxide Number (Rosmayani H, 2014)

Weigh 5 g of oil then put it in a 250 ml Erlenmeyer flask. Next, into the flask, add 30 ml of a mixture of 55 ml of chloroform, 20 ml of glacial acetic acid and 25 ml of methanol. The solution is shaken until all the ingredients are dissolved. After all the ingredients are mixed, add 1 gram of KI crystals and let the solution sit for 30 minutes in a dark place. Then add 50 ml of distilled water. Titrate with Na₂S₂O₃ with starch as an indicator until the solution changes color from brownish yellow until it disappears (Hasibuan, 2014)^[9].

5. Purification

Degumming process

The oil was weighed in a glass beaker, then heated on a hot plate at a constant temperature of 60°C for 1 hour and stirred using a stirrer and 1% liquid phosphoric acid was added to the oil. Leave for ± 12 hours at room temperature. Then it is filtered and produces oil gum and a solid phase.

Neutralization process

The beaker glass containing degummed oil is inserted into the stirrer. The stirrer is rotated, making sure the stirrer is not rotated too fast so that there is no movement that causes the sample to spill. The whitening that has been dissolved using distilled water is poured in slowly. Leave for ± 30 minutes, then filter (Meilano, 2017)^[12].

Results and Discussion

In this research, the whitening used is whitening which is usually used for betel quid. This whitening is made by burning kimah shells as in Figure 1a. The result of burning is whitening as in Figure 1b.

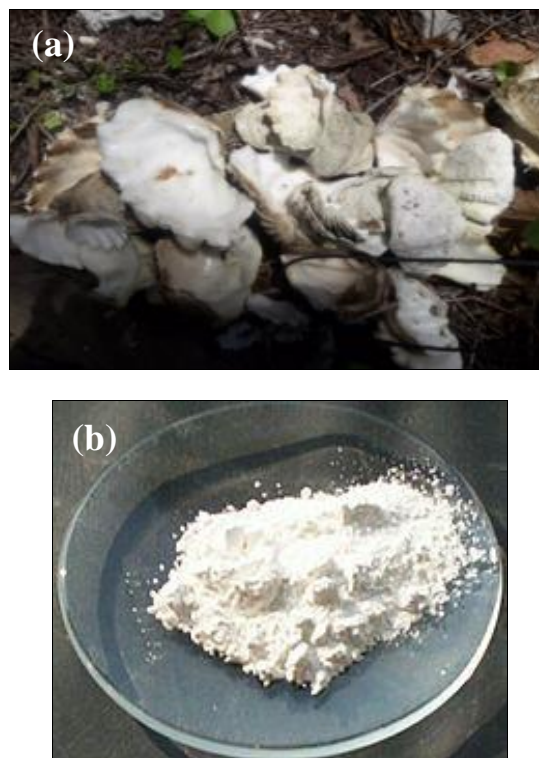


Fig 1: (a) Kimah clam shells, (b) Lime betel

In the clam shells there is calcium carbonate (CaCO₃). Burning or heating raw lime calcium carbonate (CaCO₃) at temperatures above 825°C will produce quicklime or lime oxide (CaO) (Hariyati *et al.*, 2019)^[8]. The reaction equation is as follows:



Cooking oil is made in the conventional way as is usually done by coconut farmers. To determine the quality of the cooking oil, water content, acid number, free fatty acids and peroxide value are tested (Kristianingrum, 2005^[11]; Ervina *et al.*, 2014; Suroso, 2013)^[20]. The results obtained can be seen in Table 1.

Table 1 shows that only water content meets the standards, while other quality factors have values far above the threshold. The results obtained in testing village cooking oil were not much different from the results of the quality test carried out by (Asni & Yanti, 2012) which stated that traditional oil did not meet the SNI for coconut oil. Because of this, the village's cooking oil must be purified. The method used is through a degumming and neutralization process (Kristianingrum, 2005^[11]; Suroso, 2013^[20]; Selfiwati, 2003^[16]; Asni & Yanti, 2012).

Table 1: Kampung cooking oil test results

Quality factor	Kampung cooking oil	SNI for cooking oil
Water content (%)	0.3	0.3
Acid number (mgNaOH/g)	7.0	0.60
Free fatty acids (%)	4.5	0.3
Peroxide value (meq/kg)	11	1

In this research, the degumming and neutralization process was carried out by adding a 0.15% whitening solution. The amount of whitening solution to be added is measured according to the free fatty acid content obtained. As a benchmark, litmus paper or a pH meter is used. After adding

the whiting solution, soap/soapstock is formed. This soap was separated using a Centrifuge at 1000 rpm for 5 minutes. Next, the water content, acid value, free fatty acids and peroxide value were tested again. The test results can be seen in Table 2.

Table 2: Test results after purification

Quality factor	Kampung cooking oil	SNI for cooking oil
Water content (%)	0.4	0.3
Acid number (mgNaOH/g)	0.5	0.60
Free fatty acids (%)	0.3	0.3
Peroxide value (meq/kg)	1	1

1. Water content

The principle of determining water content using the oven method is to evaporate the water contained in the oil. Water is a constituent whose presence in oil is very undesirable because it will produce free fatty acids which cause rancidity. The results of testing the water content of village cooking oil can be seen in Table 1, which shows that the water content meets SNI 01-3741-2002, namely a maximum of 0.3%. Meanwhile, after the purification process, it can be seen in Table 2, the water content does not meet SNI 01-3741-2002. After the purification process the water content increases.

The increase in water content occurred because the whiting used was made with the addition of distilled water. High water content can also be obtained from air humidity during storage caused by oxidation reactions. Apart from that, it can also be caused by damaged or rotten fruit. High water content will accelerate oil rancidity. Because high water content will result in hydrolysis of fat, where hydrolysis of oil will produce glycerol and free fatty acids which cause rancidity and produce a rancid odor in the oil. Because the higher the water content, the lower the quality of the oil (BSN, 2012; Kristianingrum, 2005^[11]; Ervina *et al.*, 2014; Suroso, 2013)^[20]. One way to reduce water content is to use adsorbents.

2. Acid numbers

In determining the acid number, the method used is the titration method. Hot ethanol is added to the oil so that the oil can dissolve so it is easy to titrate because oil does not dissolve in water. The results obtained before refining can be seen in Table 1. The oil has an acid content of 7.0 mg NaOH/g which does not meet SNI 01-3741-2002, namely a maximum of 0.60. The high acid number means that many of the triglycerides contained in village cooking oil are broken down into free fatty acids due to hydrolysis reactions. This can happen in the process of processing oil that is heated at high temperatures. After the purification process, it can be seen in Table 2. The research results show that the acid level is 0.5 mg NaOH/g and meets SNI 01-3741-2002. The purification process using a whiting lime solution is very effective in that it can reduce the acid level. The results of this research are in line with research by Meilano (2017)^[12] and Suroso (2013)^[20].

3. Free fatty acids

The test results for free fatty acid levels in village cooking oil before refining were 4.5%, including the high category (Table 1), not meeting the requirements of SNI 01-3741-2002, namely a maximum of 0.3%. High fatty acids are

influenced by the oil processing process which is processed using heating at high temperatures (Ana *et al.*, 2015^[1]; Asni & Yanti, 2012). The free fatty acid test results after the purification process decreased, namely 0.3 (Table 2), which meets SNI 01-3741-2002.

Purification by degumming and neutralization can reduce free fatty acid levels. To neutralize the free fatty acids in the oil, an alkaline solution, namely 0.15% whiting, is added. After adding whiting, a precipitate occurred. The precipitate formed is the result of a reaction between the alkaline solution and the free fatty acids in the oil, called the soap formation process. The neutralization reaction causes free fatty acids to separate into soap so that it is easily separated and the free fatty acid content becomes lower (BSN, 2012; Derlean, 2009; Meilano, 2017)^[12]. The decrease in free fatty acid levels was supported by the pH test carried out. Before the oil is added with whiting, it has a pH of 4.0. But after the village cooking oil was added with Betel Lime, the pH value became 7. This means that before the betel lime was added, the village cooking oil was still acidic. And after adding whiting it is neutral.

4. Peroxide number

The peroxide number is a level that indicates the level of oil damage due to oxidation. High levels of peroxide indicate that the oil will soon become rancid. The results of this research show that the peroxide value of village cooking oil is still high, namely 11.0 (meq/kg) and does not meet SNI 01-3741-2002, namely, a maximum of 1%. Then the resulting oil will experience a rapid process of rancidity (BSN, 2012; Ervina *et al.*, 2014; Hasibuan, 2014^[9]). In general, high peroxide levels occur due to the oxidation process. Oxidation can take place when there is contact between oxygen and oil (Kataren, 2005)^[10].

The peroxide number test results after purification decreased and met SNI 01-3741-2002 (Table 2). The oil peroxide value is reduced or not more than 1%. This decrease occurred because a reaction occurred between free fatty acids and peroxide polymer compounds with the basic solution of Betel Lime, namely $\text{Ca}(\text{OH})_2$. This research is in line with research by Meilano *et al* (2017)^[12] that through the purification process there will be a decrease in the peroxide value. The quality of oil due to damage by oxidation and polymerization can be seen from the peroxide value, this means that the refining process produces oil with better quality (Anonim, 2012; Ervina *et al.*, 2014; Hasibuan, 2014)^[9].

Conclusion

Based on the research results, it was found that the addition of 0.15% concentration of whiting in the degumming and neutralization process could reduce the acid value to 0.5 mg NaOH/gr, the peroxide value to 1meq/kg and the free fatty acid content to 0.3%. This means that after the purification process the village cooking oil is tested to meet the established SNI No. 7709-2012 standards. However, the water content is still not good because it exceeds the maximum SNI limit.

Reference

- Ana MT, Pujiono FE, Lukis PA. Pengaruh Lama Pemanasan Terhadap Kualitas Minyak Goreng Kemasan Kelapa Sawit. Jurnal Wiyata, 2015, 2(2).

2. Anonim. Pengembangan Teknik Pengolahan dan Penjernihan Minyak Kelapa Hasil IKM. Balai Penelitian dan Pengembangan Industri, Proyek Pengembangan dan Pelayanan Teknologi Industri Sulawesi Bagian Utara, Manado, 2002.
3. Asni N, Yanti L. Identifikasi Analisis Mutu Minyak Kelapa Di Tingkat Petani Provinsi Jambi. Jurnal. Balai Pengkajian Teknologi Pertanian Jambi, 2012.
4. BSN. Standar Nasional Indonesia (SNI) 7709-2012 Minyak Goreng Sawit. Badan Standardisasi Nasional, Jakarta, 2012.
5. Derlean A. Pengaruh Suhu Dan Lama Pemanasan Terhadap Kerusakan Minyak Kelapa. Jurnal. Universitas Darussalam, 2009.
6. Ervina U T, Dian S, Lia A. Uji Kadar Air dan Asam Peroxida Pada Minyak Kelapa Tradisional. Jurnal. Universitas Negeri Gorontalo. Gorontalo, 2014.
7. Gumus P, Dekker EA, Maskun M. Neutralization of Sun Flower Seed by $\text{Ca}(\text{OH})_2$, MgO and Na_2SiO_3 As An Alternative to NaOH . Fresenius Environmental Bulletin, 2020;29(9):7913-7921.
8. Hariyati, Anis S, M Agus W. Ekstraksi Kalsium Karbonat (CaCO_3) Dari Bahan Dasar Cangkang Kerang Ale-Ale (Meretrix meretrix) Pada Temperatur Kalsinasi 500°C . Jurnal. Universitas Tanjungpura, 2019.
9. Hasibuan R. Peningkatan Angka Peroksida Pada Minyak Goreng Curah Terhadap Penggorengan Berulang Tempe. Jurnal. Jurusan Analisis Kesehatan Politeknik Kesehatan Kemenkes. Medan, 2014.
10. Kataren S. Pengantar Teknologi Minyak dan Lemak Pangan. Penerbit Universitas Indonesia (UI-Press), Jakarta, 2005.
11. Kristianingrum S. Berbagai Metode Uji Kualitas Minyak Kelapa. Jurnal. Universitas Negeri Yogyakarta, 2005.
12. Meilano. Pengaruh Proses Degumming dan Netralisasi Terhadap Sifat Fisiko Kimia dan Profil Asam Lemak Penyusun Minyak Biji Gambas. *Chimica et Natura Acta*, 2017;5(2):50-56.
13. Mudjiono. Catatan Beberapa Aspek Kehidupan Kimah, Suku Tridacnidae (Molusca, Pelecypoda). Jurnal. Balai Penelitian dan Pengembangan Biologi Laut, Pusat Penelitian dan Pengembangan Oseanologi-LIPI, Jakarta, 1988.
14. Musyaroh, Hidayat N. Pengaruh Lama Waktu Pengadukan dan Konsentrasi NaOH Pada Proses Pemurnian Minyak Goreng Superworn Cooking (*Zophobas morio*). Jurnal Universitas Brawijaya Malang, 2018.
15. Rizkevina Q. Keanekaragaman Jenis dan Distribusi Family Tridacnidae (Kerang Kimah) Di Perairan Pulau Karang Congkak, Kepulauan Seribu. Skripsi. Universitas Islam Negeri Syarif Hidayatullah. Jakarta, 2014.
16. Selfiawati E. Kajian Proses Degumming Dan Netralisasi Pada Pemurnian Minyak Goreng Bekas. Skripsi. Bogor, 2003.
17. Setiaji B. Menyingkap Keajaiban Minyak Kelapa Virgin, Pusat Pengolahan Kelapa Terpadu Coconut Center Oil, 2005.
18. Subagio A. Potensi Daging Buah Kelapa Sebagai Bahan Baku Pangan Bernilai. Jurnal Universitas Jember, 2010.
19. Suntoro A, Suyatno, Sylviana. Mempelajari Penambahan Kapur Sirih $\text{Ca}(\text{OH})_2$ Sebagai Bahan Penghambat Kerusakan Pada Nira Kelapa. Jurnal. Universitas Muhammadiyah Palembang, 2016.
20. Suroso AS. Kualitas Minyak Goreng Habis Pakai Ditinjau Dari Bilangan Peroksida, Bilangan Asam dan Kadar Air. Jurnal. Pusat Biomedis dan Teknologi Dasar Kesehatan, Badan Litbangkes, Kemenkes RI, 2013.
21. Sutanto S, Abriana A. Penerapan Teknologi Pemurnian Minyak Goreng Rakyat pada Masyarakat Pengolah Minyak Goreng. Jurnal Dinamika Pengabdian, 2016, 1(2).
22. Tri W, Purwanto, Suko H, Bambang TP, Rully S, Nuzul WD. Upaya Peningkatan Kualitas Minyak Kelapa yang Dibuat Dari *Cocos Nucifera L* dengan Berbagai Metode Kimia dan Fisik. Jurnal. Universitas Airlangga. Surabaya, 2010.