

RESEARCH ARTICLE



# Qualitative and Quantitative Analysis of Selected Fats and Oils: Butter, Coconut Oil (*Pliek U*), and Sunco

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## ABSTRACT

The purpose of this research is to evaluate the qualitative and quantitative properties of various fats and oils, including coconut oil (*Pliek U*), Sunco cooking oil, and butter. *Pliek U* is a traditional coconut oil product, and the term originates from the Acehese language spoken in Aceh Province, Indonesia. The qualitative and quantitative tests conducted include solubility tests, acrolein tests, saponification reactions, and rancidity tests. Physical changes, specific chemical reactions, and quantitative parameter measurements were conducted on each sample. The test results show that the three samples have unique characteristics. Coconut oil and Sunco dissolve perfectly in organic solvents, but butter does not dissolve at all. Through the characteristic smell of acrolein, the acrolein test shows that all three samples contain glycerol. Compared to butter, the saponification reaction produced more soap in coconut oil and Sunco. This shows the difference in fatty acid content. The rancidity test shows that butter, with a higher saturated fat content, is more stable than coconut oil and Sunco. Sunco shows the highest level of double bonds (+++), followed by coconut oil (++) and butter (+). The research results show that Sunco cooking oil has a higher content of unsaturated fats, making it suitable for health-supporting consumption, while butter, due to its dominant saturated fat content, becomes more stable. Meanwhile, coconut oil (*Pliek U*) shows a balanced level of saturated and unsaturated fats. This study provides insights into the chemical properties and quality of fats and oils. This can be useful for further use and processing.

## KEYWORDS

Fats; oil; qualitative test; quantitative test; coconut oil (*Pliek U*); Sunco; butter

## 1. Introduction

Fats and oils are important components in daily life, both as energy sources, industrial raw materials, and essential components in cooking processes. Fats are

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generally solid at room temperature, while oils are liquid, although both consist of triglycerides that have interrelated chemical and physical properties (Mulyani & Sujarwanta, 2018). The presence of fats and oils in food not only provides flavor and texture but also plays an important role in the physiological functions of the body. Therefore, understanding the characteristics of fats and oils becomes an important aspect in the food industry and public health.

The quality of fats and oils can be assessed using qualitative and quantitative tests. Qualitative tests aim to detect the presence of fat compounds through specific chemical reactions, while quantitative tests involve the analysis of specific parameters such as free fatty acid content, iodine value, and peroxide value (Priskila & Darmawan, 2022). These parameters provide an overview of oxidative stability, the content of saturated or unsaturated fatty acids, as well as the potential for oxidative damage that can affect the food safety and nutritional value of the material (Dragoev, 2024).

Traditional coconut oil, or known as "pliek u" in Aceh, is one of the oil products that is still produced traditionally and has a high content of bioactive compounds such as polyphenols and medium-chain fatty acids (Zuraidah, 2020; Azizah et al., 2023). On the other hand, packaged butter and cooking oil like Sunco are more frequently used in household and industrial needs due to their easy accessibility and storage stability. However, different processing methods can affect the nutritional content and quality of the oil (Keceli & Mertoglu, 2024).

The use of fats and oils that do not meet quality standards can have adverse effects on health. For example, the high levels of saturated fatty acids in butter can increase the risk of cardiovascular diseases, while oxidized oils can produce toxic compounds harmful to the body. Therefore, qualitative and quantitative analysis of various types of fats and oils becomes important to determine their safety and benefits for consumers. This research was conducted to evaluate the quality of fats and oils from butter, traditional coconut oil (pliek u), and packaged cooking oil (Sunco). By using qualitative and quantitative testing methods, this research is expected to provide relevant information regarding the characteristics and quality of these materials, as well as recommendations for more optimal use.

## 2. Methodology

This research uses laboratory-scale experimental methods. The research method used in this study is a qualitative descriptive method to analyze the qualitative and quantitative properties of various fats and oils, including coconut oil (Pliek U), Sunco cooking oil, and butter. The qualitative and quantitative tests conducted include solubility tests, acrolein tests, saponification reactions, rancidity tests, unsaturation tests, and iodine number tests.

### 2.1. Tools and materials

#### *Tool*

The equipment used in the research includes 6 dropper pipettes, 1 tripod stand, 1 gauze, 1 triangle, 3 Erlenmeyer flasks 100 ml (pyrex), 1 burette, 1 stand rod, 1 clamp, 1 watch glass, 3 measuring flasks 50 ml (pyrex), 5 measuring cups 100 ml (pyrex), 5 beakers 100 ml (pyrex), 3 spatulas, 1 spirit burner, 1 evaporating dish, 20 test tubes (pyrex), and 3 stirring rods.

#### *Material*

The materials used in the research are 50 ml of coconut oil (U grade), 50 ml of sunco, butter, 20 ml of diethyl ether (Merck), 50 ml of technical ethanol 96% pa (Merck), 20 ml of chloroform (Merck), 20 ml of  $\text{CCl}_4$  (Merck), 10 ml of benzene (Merck), 3 grams of potassium hydrogen sulfate (Merck), 10 ml of potassium hydroxide (Merck), 10 ml of sodium hydroxide (Merck), 3 ml of 37% hydrochloric acid (Merck), 20 ml of aquades, Tollens reagent ( $\text{Ag}(\text{NH}_3)_2\text{OH}$ ) (Merck), 1 gram of calcium carbonate (Merck), and filter paper (Whatman).

### 2.2. Procedure

#### *Solubility Test*

Samples (3 mL Coconut Oil/ 3 mL Sunco/ 1 g Butter) each in 6 different test tubes were added with 2 mL of reagents ( $\text{CCl}_4$ ,  $\text{C}_6\text{H}_6$ , diethyl ether, hot  $\text{C}_2\text{H}_5\text{OH}$ ,  $\text{CHCl}_3$ ,  $\text{H}_2\text{O}$ ) to each test tube and shaken. Then the results were observed.

### *Acrolein Test*

2g of  $\text{KHSO}_4(\text{s})$  were placed in each of 3 different test tubes, 1 mL of sample (coconut oil, sunco, butter) was added, and then heated. Then the results were observed.

### *Saponification Reaction*

4-5 drops of the sample (coconut oil, sunco, butter) + 3 mL of  $\text{H}_2\text{O}$  added with 1 mL of alcoholic KOH. 1 mL of alcoholic NaOH was added to another treatment of the same sample and heated until it thickened and soap was formed. Then observe and weigh the results.

### *Test of Acidity*

2 mL of the sample (coconut oil, sunco, butter) is added to 1 mL of HCl/p. Soak the filter paper in Tollen's reagent. 1 gram of  $\text{CaCO}_3$  is added to the test tube containing the previous sample. Hang a filter paper in the test tube and close the test tube. Then observe the results

## 3. Results and Discussion

### *Solubility Test*

The solubility test results show that fats and oils have different solubility properties depending on the type of solvent used. Fats and oils generally dissolve in non-polar solvents such as chloroform ( $\text{CHCl}_3$ ), hot ethanol ( $\text{C}_2\text{H}_5\text{OH}$  hot), benzene ( $\text{C}_6\text{H}_6$ ), carbon tetrachloride ( $\text{CCl}_4$ ), and diethyl ether. Meanwhile, fats and oils are insoluble in water ( $\text{H}_2\text{O}$ ), which is a polar solvent. This is consistent with the chemical properties of fats and oils, which consist of triglycerides, non-polar molecules that are more soluble in non-polar solvents (Khathir et al., 2023). The results of the solubility test are presented in Table 1, which was tested on three samples.

**Table 1.** Results of the Fat Solubility Test

Sample	reagents					
	$\text{CHCl}_3$	$\text{C}_2\text{H}_5\text{OH}$ hot	$\text{C}_6\text{H}_6$	$\text{CCl}_4$	Diethyl Eter	$\text{H}_2\text{O}$
Coconut oil (Plik U)	+	+	+	+	+	-
Sunco	+	-	+	+	+	-
Butter	+	-	+	+	+	-

Note: + indicates late



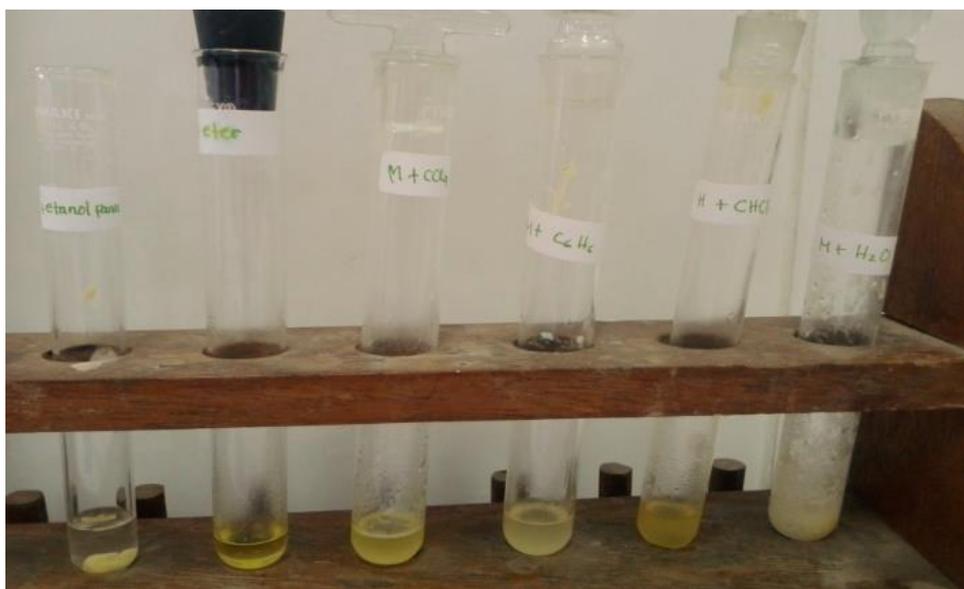
**Figure 1.** Results of the Coconut Oil Solubility Test

Figure 1 shows the treatment results of the coconut oil solubility test (plik u), indicating complete solubility in all tested non-polar solvents, including hot ethanol. This indicates that coconut oil has a dominant triglyceride content with a simple molecular structure, allowing it to dissolve efficiently in various non-polar solvents (Setyopratiwi et al., 2021).



**Figure 2.** Results of the Sunco Solubility Test

Packaged cooking oil (Sunco) has a solubility like coconut oil, except in benzene ( $C_6H_6$ ), where Sunco does not completely dissolve (Figure 2). This may be due to differences in processing methods and the presence of certain additives or emulsifiers in packaged cooking oil. The addition of stabilizer or antioxidant compounds to packaged cooking oil can affect the chemical interactions between the oil and the solvent (Prayogo et al., 2021).



**Figure 3.** Results of the Butter Solubility Test

Butter, which is solid at room temperature, shows poorer solubility compared to coconut oil and Sunco (Prasatya et al., 2020). The solubility of butter is lower in diethyl ether and benzene. This is due to the high content of saturated fatty acids in butter, which have more complex molecular chains, thereby reducing its solubility in some non-polar solvents (Mamuaja, 2021)

The difference in solubility between the samples can be attributed to variations in the saturation level of fatty acids. Coconut oil, which is rich in saturated fatty acids, has a more uniform solubility level compared to Sunco, which is richer in unsaturated fatty acids (Figure 3). Sunco shows significant solubility differences in hot ethanol, indicating the presence of hydroxyl groups in the unsaturated bonds that affect their solubility (Fitriana & Fitri, 2020).

The very low solubility in water for all samples reinforces the hydrophobic nature of fats and oils. This phenomenon is caused by the inability of lipid molecules to form sufficient hydrogen interactions with water molecules; the longer the carbon chain of a lipid, the lower its solubility in polar solvents. Another factor that affects solubility is temperature. Solubility in hot ethanol shows that an increase in temperature raises the kinetic energy of the molecules, allowing the solvent to break the interactions between lipid molecules. This is in line with the research (Astuti et al., 2022) which concludes that an increase in temperature can facilitate solvent-solute interactions by weakening the intermolecular forces of lipids.

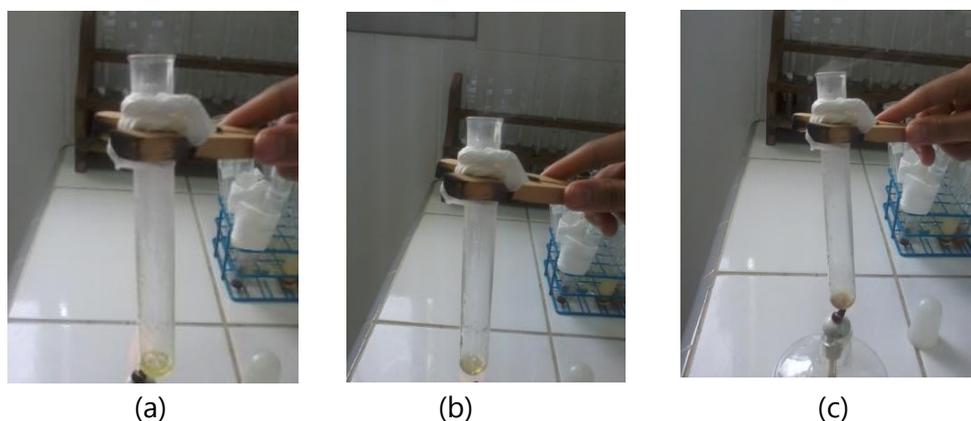
### *Acrolein Test*

The result of the acrolein test aims to identify the presence of glycerol in fats and oils. When glycerol is heated in an acidic atmosphere, it dehydrates into acrolein, characterized by the emergence of a distinctive pungent odor and the presence of white smoke. In this study, all three samples of coconut oil, Sunco, and butter showed positive results (+), meaning all samples produced the smell of acrolein and white smoke during the test. The results of the acrolein test are presented in [Table 2](#) and [Figure 4](#), which was tested on three samples.

**Table 2.** Results of the Fat Acrolein Test

Sample	Smell
Coconut oil (Plik U)	+
Sunco	+
Butter	+

Note: + indicates the presence of white smoke



**Figure 4.** Acrolein Test Results (a) Coconut Oil, (b) Sunco, (c) Butter

Coconut oil produces a strong acrolein odor, indicating that this oil has a high triglyceride content with glycerol as one of its main components (Buluk et al., 2023). The medium-chain fatty acid content in coconut oil can easily dehydrate to produce acrolein during heating (Monica, 2018). Then, the positive results on Sunco (packaged cooking oil) indicate that the processing of cooking oil still retains the presence of triglycerides, even though the oil has undergone a refining process. Additives or emulsifiers added to cooking oil do not affect the glycerol dehydration process (Mulyati et al., 2015). Furthermore, the test on butter also showed positive results in the acrolein test. Although butter has a higher saturated fat content compared to liquid oils, the heating process still breaks down triglycerides into glycerol, which can dehydrate into acrolein. Pure coconut oil has higher free fatty acids, lower moisture content, and higher acid value compared to refined oils and cold-pressed oils, making it suitable for cooking and natural preservation (Maurikaa et al., 2020). Whereas the higher water content in butter compared to oil can cause slower heating, it does not affect the result (Ahmed et al., 2024)

Overall, coconut oil and Sunco show lower acrolein intensity compared to butter. This may be due to differences in water content and glyceride structure. Butter, which has a higher water content, tends to facilitate the decomposition of glycerol at low temperatures. Water content affects the decomposition temperature of lipids, where glycerol decomposes more easily under humid conditions. Acrolein also forms more quickly in lipids with a high content of unsaturated fatty acids. Sunco, which is rich in oleic and linoleic acids, produces white smoke more quickly compared to coconut oil. The double bonds in unsaturated fatty acids are more susceptible to thermal dehydration, producing products like acrolein. Positive results in all samples indicate that triglycerides are the main component in the fats and oils tested. This test is not only useful for identifying the presence of glycerol but also provides insights into the thermal and chemical properties of fats and oils under heating conditions.

### *Saponification Reaction*

The results of the fat saponification reaction show differences in the mass of soap produced by three fat samples: coconut oil, Sunco, and butter, using alcoholic NaOH and alcoholic KOH base solutions. The saponification process involves the hydrolysis of triglycerides by a base, producing soap (fatty acid salt) and glycerol. The results

of the saponification reaction are presented in [Table 3](#), which was tested on three samples.

**Table 3.** Results of the Saponification Reaction on Fats

Sample	Mass of Soap (g)	
	NaOH is alcoholic	KOH is alcoholic
Coconut oil (Plik U)	0,024	0,0167
Sunco	0,0178	0,0142
Butter	0,0062	0,0053



**Figure 5.** Results of Soap Formed

Coconut oil produces the highest soap mass with alcoholic NaOH (0.024 g) and alcoholic KOH (0.0167 g). This is due to the triglyceride content in coconut oil, which is dominated by lauric acid (a medium-chain fatty acid), making it more reactive in the saponification process (Imamsyah & Paramita, 2022). The high soap yield indicates that coconut oil is very suitable for use as a raw soap material. The fatty acid content in coconut oil is known to provide good foaming properties in soap (Widyasanti et al., 2019).

Sunco cooking oil produces a lower soap mass compared to coconut oil. This cooking oil undergoes a refining process that reduces the free fatty acid content, thereby decreasing efficiency of saponification. However, this result remains

significant because cooking oil contains enough triglycerides to produce soap. This is because the optimal NaOH concentration for making soap from cooking oil is around 50%, which can produce a solid and environmentally friendly product (Rahayu et al., 2021). Then, the high-water content in butter can reduce the concentration of fat to react with the base. In addition, the fat content in butter is dominated by saturated fats with long carbon chains, which require more energy for the saponification process.

The saponification reaction also shows the influence of the type of base used. NaOH produces harder and more soap compared to KOH, which tends to produce liquid soap (Kurniawati & Paramita, 2022). The basic properties, concentration, and reaction temperature play an important role in the efficiency and characteristics of the produced soap (Silsia et al., 2017). The saponification reaction with alcoholic NaOH tends to produce a higher soap mass compared to alcoholic KOH. NaOH is more effective in forming solid fatty acid salts, while KOH produces softer soap. These results are consistent with previous research, which shows that the properties of the base affect the efficiency of saponification.

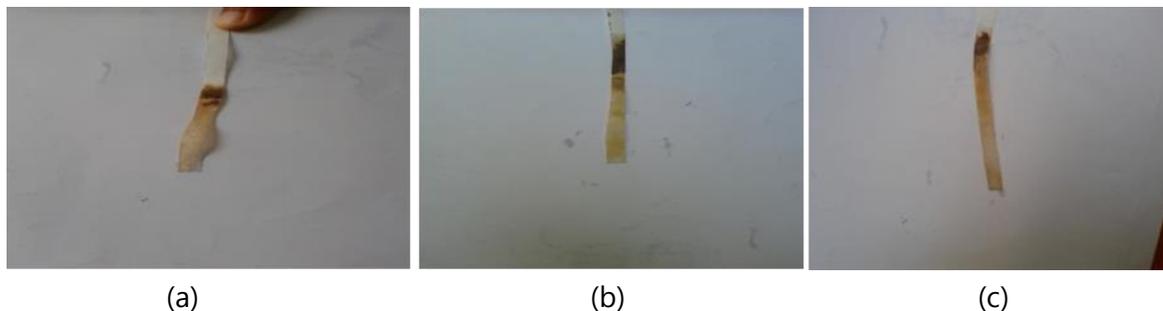
### *Test of Acidity*

All fat samples, namely coconut oil, Sunco cooking oil, and butter, showed positive (+) results for rancidity. This indicates that all three samples underwent the process of fat oxidation or hydrolysis, producing compounds that cause rancid odors such as aldehydes, ketones, and free fatty acids. The results of the rancidity test are shown in Table 4 and Figure 6.

**Table 4.** Results of the Fat Stability Test

Sample	Rancidity
Coconut oil (Plik U)	+
Sunco	+
Butter	+

Note : + indicates rancidity



**Figure 6.** Rancidity Test Results for (a) Coconut Oil, (b) Sunco, and (c) Butter

Coconut oil tends to go rancid easily because it contains medium-chain fatty acids, such as lauric acid, which are more reactive to oxidation (Mela & Bintang, 2021). In addition, the natural antioxidant content in coconut oil is relatively low, making it less able to inhibit the oxidation process (Suraidah et al., 1930). Sunco cooking oil becomes rancid because the heating process during repeated use can trigger fat degradation. This heating accelerates the formation of free radicals and carbonyl compounds that cause rancidity. Rancidity in butter is mainly caused by the high water and saturated fat content. Water content can trigger a hydrolysis reaction that produces free fatty acids, while saturated fat is more susceptible to hydrolysis than oxidation.

#### 4. Conclusion

Based on the results of the study, qualitative and quantitative analysis of fats and oils showed differences in characteristics between coconut oil (Pliek U), Sunco cooking oil, and butter. Solubility tests showed that all samples were soluble in non-polar solvents but insoluble in water, with coconut oil having the best solubility. The acrolein test proved the presence of glycerol in all three samples, indicating that all contained triglycerides. The saponification reaction showed that coconut oil produced the largest amount of soap, followed by Sunco and butter. This shows that coconut oil has a more reactive triglyceride content than Sunco cooking oil and butter. Rancidity tests show that butter is more stable than coconut oil and Sunco due to its higher saturated fat content. Sunco has the highest level of unsaturation, making it more susceptible to oxidation but healthier than butter due to its higher unsaturated fat content..

## Conflict of interest

The author declares that they have no conflict of interest.

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