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Analysis FTIR Test, Viscosity, Density, Acid Number, and Organoleptic in Bulk Cooking Oil with Packaged Cooking Oil

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Abstract: The purpose of this study is to compare packaged and bulk cooking oils. The FTIR test, viscosity, density, acid number, and organoleptic are all used as research methods. With FTIR results on the C-H spectral group of alkanes seen at 1463.78 cm^{-1} and 1743.63 cm^{-1}, and the tertiary C=O ester group of triglyceride seen at 1743.66 cm^{-1} and 1743.63 cm^{-1}. It was determined that bulk cooking oil includes more hydrogen and double bonds than packaged cooking oil. Bulk cooking oil viscosity testing with packaging showed that it was between 38 and 37 MPa, had densities of 0.92 and 0.90 gr/ml, and acid numbers of 0.18 and 0.11 mg of potassium hydroxide. Packaged cooking oil has a more appealing aroma than bulk cooking oil, and both have a sticky flavor. Bulk cooking oil is dark, but packaged oil is yellow. According to the study of the test results, bulk cooking oil is of lower quality and has a greater impact than packaged oil.

Keywords: Acid Number; Cooking Oil; Density; FTIR; Organoleptic

Introduction

Oil is a nutritional ingredient that is crucial for preserving bodily health. Linoleic, linolenic, and arachidonic acids are among the important fatty acids found in oils, especially vegetable oils (Guidoni et al., 2019; Ruiz Ruiz et al., 2017; Stawarska et al., 2020). Oil serves as a solvent for the vitamins A, D, E, and K as well as a source of those nutrients. Oil is taken from several plants to make vegetable oil (Bharti & Singh, 2020; Yara-Varón et al., 2017). Vegetable oils come in a variety of forms, such as peanut, sunflower, corn, soybean, sesame, coconut, olive, and others.

In 2022, Indonesia will experience a crisis, one of which is that the value of the rupiah continues to weaken. The weakening of the rupiah causes an increase in the price of cooking oil (Fatwa, 2020; Hutauruk, 2022; Mahaputra & Saputra, 2022). As a result, some people who were less fortunate initially used packaged cooking oil and switched to bulk cooking oil, which is cheaper and can be found in many traditional markets.

Cooking oil made of palm is referred to as "bulk cooking oil" when it is offered to customers unpackaged and without a label or brand. This bulk oil is a non-pure palm oil derivative product. Cooking oil that is purchased in bulk does not undergo any sort of pre-filtering (Mohd Noor et al., 2018). This causes bulk cooking oil to have low oil resistance or cloud point (CP) quality, namely at level 12 (Onoji et al., 2016). The lower the CP of cooking oil, the better its durability so it doesn't fog up when placed at low temperatures. Low CP cooking oil is also cleaner and healthier to consume. In contrast, bulk cooking oil is considered to be less hygienic (Aguado-Deblas et al., 2020; Panchal et al., 2020).

Although it is very difficult to separate cooking oil from people's lives, there is an issue in the community that arises from not being aware of the physical quality of cooking oil that has been used more than twice. According to Sahasrabudhe et al. (2017), using cooking oil more than twice will cause it to change in viscosity. Using cooking oil more than twice is extremely detrimental for one's health, particularly for blood

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pressure and cholesterol (Ganesan et al., 2018; Jaarin et al., 2018). Many people often consume oil more than twice due to several factors, including economic factors, feelings of affection, and loss if the cooking oil is not used because it must be thrown away and replaced with a new one (Hahladakis et al., 2018; Popkin et al., 2020).

This study aims to compare bulk cooking oil with packaged cooking oil through analysis of FTIR, viscosity, density, acid number, and organoleptic tests.

Method

Tools and Materials

Aluminum bowls, 5 mL measuring cups, electric stoves, ohaus balances, dropper pipettes, analytical balances, elenmeyer, burettes, stative burettes, 250 mL beaker glass, and pycnometer were among the equipment utilized in this investigation.

Both bottled and bulk cooking oil are used as basic materials. In the solutions, ethanol, 0.1 N KOH, and PP indicator were all used.

Viscosity Determination

The NDJ-8S viscometer, which employed a drive rotor known as a digital rotary viscometer, was utilized in this work to measure viscosity. The specifications of the NDJ-8S viscometer include a digital display; rotor speed using 0.3/0.6/1.5/3.0/6.0/12.0/30.0/60.0; speed adjustment using eight levels; rotor using 1, 2, 3, 4, 0, (optional); measurement range (mPa.s) approx. 1~2×106mPa.s; and 2% measurement error

Determination of Density

The pycnometer was cleaned and dried for 15 to 30 minutes in an oven set at 105 °C. After that, the pycnometer was left in a desiccator for 10 to 15 minutes. Keep a record of the pycnometer's volume usage (50 ml, 25 ml, or 10 ml). The sample is placed inside the pycnometer up to the neck after the pycnometer has been weighed. Check for air bubbles inside the pycnometer and then secure the cover until the sample has completely filled the capillary tube. Using a paper towel, dry the pycnometer's exterior. Count the sample-containing pycnometer. Utilize the formula below to determine the density information from the data difference.

$$\rho = \frac{m}{v} \qquad (1)$$

Information:
ρ = density of a substance (gr/cm3)
m = mass of a substance (gr) -> (filled pycnometer – empty pycnometer)
v = volume of a substance (cm^3)

Determination Acid Number

25 mL of 95% ethanol was added along with a total of 5 grams of oil. The mixture is heated in a water bath for about 10 minutes, or until the oil melts. A pink color eventually appeared after the mixture was titrated with 0.1 N KOH solution and 3-5 drops of PP indicator.

$$Acid\ number = \frac{V_{KOH} \times N_{KOH} \times Mr_{KOH}}{m_{sample}} \qquad (2)$$

Explanation:
V_{KOH} = Vol KOH for titration (ml)
N_{KOH} = Normalitys KOH (N)
Mr_{KOH} = 56.1 gram/mol
m_{sampel} = Sample of mass (gr)

Organoleptic Determination

Organoleptic determination was carried out by observing the smell, taste, and color of packaged oil and bulk oil using the five human senses.

Result and Discussion

The findings of the collected data were subjected to data analysis in order to determine the physical and chemical distinctions or connections between bulk oil and packaged oil. Cooking oil was heated for 20 minutes in this study's treatment for both bulk and bottled cooking oil.

FTIR Test

To determine the existence of molecular groups, a qualitative examination utilizing Fourier Transform Infrared (FTIR) Spectroscopy was carried out. In this case, the sample's hydroxyl group concentration is the determining factor. The FTIR spectrum test results for bulk and packaged cooking oil for before and after treatment are shown in Figures 1 and 2.

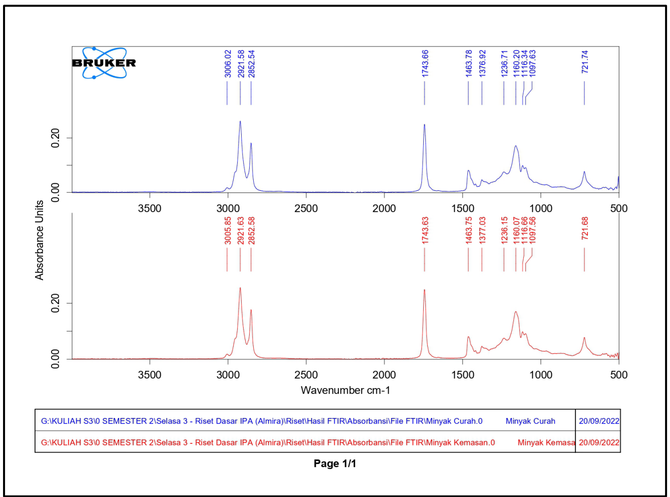

Figure 1. Spectral Absorbance of Bulk Cooking Oil and Packaged Cooking Oil before Treatment

Figure 2 shows the absorbance spectral results of bulk cooking oil and packaged cooking oil before treatment between 4000 cm^{-1} to 500 cm^{-1}. The results of analysis using FTIR obtained the spectral C-H group of alkanes at 1463.78 cm^{-1} and 1463.75 cm^{-1} for bulk oil and packaged oil which are hydrogen stretching areas. Whereas in bulk and packaged oil, 1743.66 cm-1 and 1743.63 cm-1 are stretches from the spectral C=O ester group of triglycerides (TGA) which are areas of double bond stretching. This spectral shows the difference in frequency and absorbance spectral values between bulk oil and packaged oil, even though the two samples both have the dominant component in oil fat. The area between 1500 cm^{-1} – 500 cm^{-1} is the most complex spectrally due to the complicated stretching and bending of the substance molecules and is known as a fingerprint. This area is often used to differentiate identification between compounds (Lucarini et al., 2020).

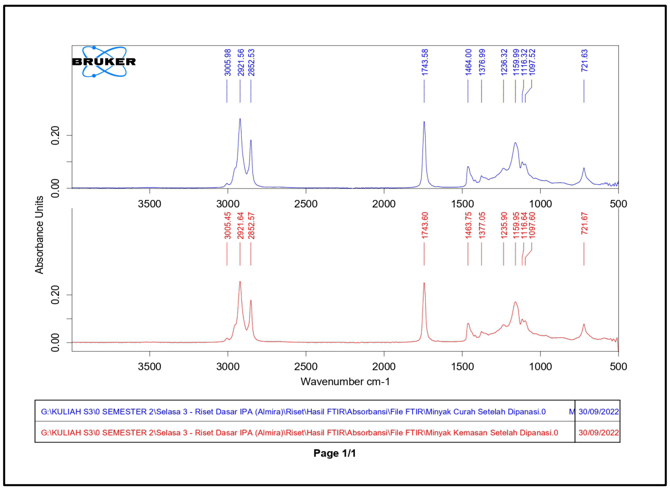

Figure 2. Spectral Absorbance of Bulk Cooking Oil and Packaged Cooking Oil after Treatment

Figure 2 shows the results of the FTIR absorbance spectral for bulk cooking oil with packaged cooking oil after being treated. Alkane C-H spectral groups at 1464.00 cm^{-1} and 1463.75 cm^{-1} for bulk oil and packaged oil. These data when compared with Figure 1, the spectral value of bulk oil increased while the spectral value of the packaging did not change. The results of Figure 2 and Figure 1 show that the spectral value reduction in bulk oil is greater than packaged oil, with the spectral results for the C=O group of triglycerides obtained 1743.58 cm^{-1} and 1743.60 cm^{-1}.

Viscosity Test

Viscosity is a parameter used to describe oil quality (Musa et al., 2022). Good cooking oil has a high viscosity value before treatment (Syaifudin et al., 2019). Table 1 shows the viscosity values of bulk cooking oil and packaged cooking oil before being treated.

Table 1. Viscosity of Bulk Cooking Oil and Packaged Cooking Oil Before Treatment

Rotor	Speed	Bulk Oil		Packaged Oil	
		Data (mPa.s)	Percent (%)	Data (mPa.s)	Percent (%)
1	6	36.00	3.60	36.00	3.60
	12	36.50	7.30	36.50	7.30
	30	37.80	18.90	37.00	18.50
	60	38.00	38.40	37.00	37.40

The results of the data in table 1 show a difference between bulk oil and packaged oil. Using rotor 1 at each speed, the highest percentage was obtained at speed 60 with bulk oil viscosity data of 38.00 mPa.s and packaged oil of 37.00 mPa.s. The viscosity of bulk oil is higher compared to packaged oil because bulk oil is a waste product from us. Whereas packaged oil has a low viscosity because packaged oil has the purity of oil that is still intact and has not been mixed with other ingredients and has not been used in frying pans.

Table 2. Viscosity of Bulk Cooking Oil and Packaged Cooking Oil After Treatment

Rotor	Speed	Bulk Oil		Packaged Oil	
		Data (mPa.s)	Percent (%)	Data (mPa.s)	Percent (%)
1	6	34.00	3.40	34.00	3.40
	12	34.50	7.00	34.50	6.90
	30	35.60	17.80	34.60	17.30
	60	36.00	36.10	35.00	35.30

One of the physical properties that change from the cooking oil heating process is the viscosity value of the oil (Jalkh et al., 2018). Table 2 shows the viscosity values of bulk cooking oil and packaged cooking oil after being treated. The viscosity value of the oil decreased significantly according to the speed of the rotor after the oil was heated by comparing in table 1 with table 2. The results before heating and after heating were 38.00 mPa.s bulk oil with 36.00 mPa.s and 37.4 mPa.s packaged oil with 35.3 mPa.s (Mudawi et al., 2014).

According to table 2's results, bulk oil has a viscosity that is higher than packaged oil at rotor speeds of 60 and 38.4% and 37.4%, respectively, when treated similarly to Table 1.

Density Test

The density of the oil is the density of the oil which affects the absorption of the oil into the fried ingredients (Ghaitaranpour et al., 2021; Jurid et al., 2020). If the density of the oil changes, it means that the level of absorption of oil into the fried ingredients during the frying process also changes.

Table 3. Density of Bulk Cooking Oil and Packaged Cooking Oil Before and After Treatment

Sample	Before treatment	After treatment
Bulk Cooking Oil	0.92 gr/ml	0.94 gr/ml
Packaged Cooking Oil	0.90 gr/ml	0.90 gr/ml

The results of table 3 show the density value of the oil after heating, the density of bulk cooking oil has changed while the density of packaged oil has remained the same. The density of the oil will change after the heating process (Victor Enearepuadoh & Evawere Abigail, 2020).

Acid Number Test

The acid number is a marker of the number of mg of KOH needed to neutralize 1 gram of cooking oil sample. The results of this experiment using the titration method. The data in table 4 before the treatment between bulk oil and packaged oil according to the conditions set by SNI 01-3741-2013 is <0.60 mg KOH/g.

Table 4. Acid Number of Bulk Cooking Oil and Packaged Cooking Oil Before and After Treatment

Sample	Before treatment (mg KOH)	After treatment (mg KOH)
Bulk cooking oil	0.18	0.25
Packaged cooking oil	0.11	0.13

The comparison before and after the treatment between bulk oil and packaged oil has a very large difference in bulk oil of 0.07 mg KOH compared to the difference in packaged oil of 0.02 mg KOH.

Fatty acids that are liberated during the hydrolysis process are referred to as free fatty acids. The quantity of free fatty acids will increase with the amount of KOH 0.1 N used to neutralize them. The quality decreases as the acid number increases.

Organoleptic Test

Table 5. Organoleptic Bulk Cooking Oil and Packaged Cooking Oil Before Treatment

Sample	Average organoleptic test		
	Smell	Flavor	Color
Bulk cooking oil	A little rancid	Sticky	Dark Yellow
Packaged cooking oil	No smell	Sticky	Clear Yellow

Table 6. Organoleptic Bulk Cooking Oil and Packaged Cooking Oil After Treatment

Sample	Average organolptic test		
	Smell	Flavor	Color
Bulk cooking oil	A little rancid	Sticky	White Yellow
Packaged cooking oil	No smell	Sticky	Clear Yellow

Tables 5 and 6 show the organoleptic characteristics of packaged cooking oil and bulk cooking oil before and after testing on five individuals. Bulk cooking oil has a stronger scent than packaged cooking oil (Putra & Azara, 2021). The hands' taste organs are used in this trial's flavor. The bulk cooking oil with packaging has a sticky taste in the taste data both before and after treatment. Cooking oil's composition determines its color. Better oil is yellow than oil that is darker in hue (Pinto et al., 2017).

Conclusion

Bulk cooking oil has a greater absorbance spectrum than packaged oil in the C-H alkane and C=O ester group spectra of triglycerides (TGA). This revealed that compared to packaged cooking oil, bulk cooking oil has a lot more hydrogen and double bonds. When heated for 20 minutes, bulk cooking oil shows a quick reduction in quality when compared to packaged cooking oil, as shown by thermal stability. the outcomes of viscosity, density, acid number, and organoleptic have strengthened. The findings of this study demonstrate that packaged cooking oil has a greater impact than bulk cooking oil and is of lower quality.

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