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Analysis of the Quality of Fresh and Used Cooking Oil Among Fried Catfish Street Vendors in the Eastern Region of Lamongan Sub-District, Lamongan District

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A B S T R A C T

Cooking oil that is repeatedly used by vendors can cause damage and a decline in quality. Moreover, it can pose health risks. Repeated use of cooking oil leads to various degradation reactions such as oxidation, hydrolysis, and polymerization. This research aims to analyze the quality differences between initial and used cooking oil. The study is a survey with a cross-sectional study method. The sampling technique used purposive sampling (13 vendors) with data analysis using a paired t-test at a 5% significance level. Cooking oil samples were taken twice a day. The chemical quality analysis results of 13 initial cooking oil samples showed that the percentage that did not meet SNI 7709:2019 standards for water content was 46.15%, free fatty acids were 46.15%, and peroxide values were 69.23%. For used cooking oil samples, the percentages that did not meet SNI 7709:2019 standards for water content were 92.30%, free fatty acids were 100%, and peroxide values were 100%. The average TBA value for all initial-use cooking oil samples was 0.44 mg MDA/kg, and for used cooking oil samples was 0.65 mg MDA/kg, both higher than the reference sample (0.15 mg MDA/kg).. The t-test results showed that there were quality differences between the initial and used cooking oil used by street vendors selling pecel lele in the eastern region of Lamongan District.

1. INTRODUCTION

1.1. Research Background

The cooking oil commonly used by Indonesian people is palm oil. Frying is a common cooking method performed by Indonesian society. The frying process can cause cooking oil to deteriorate in quality or become damaged, which affects the quality and value of the fried food [1].

One factor in the deterioration of cooking oil is repeated frying. According to Ref. [2], cooking oil that is used repeatedly can cause a decline in quality and even pose health risks. Repeated use of cooking oil at high temperatures (160-180 °C) with oxygen exposure during frying will lead to various degradation reactions such as oxidation, hydrolysis, and polymerization [3]. During the frying process, cooking oil undergoes various chemical reactions, including hydrolysis, oxidation, isomerization, and polymerization, producing volatile components. High-temperature heating will have a destructive thermal effect capable of killing microbes and inactivating enzymes present in food [4].

Lamongan District is one of the districts in Lamongan Regency. Lamongan District is located in the center of Lamongan Regency. The strategic location of this area means that many people take advantage of it by selling food in the city center. Lamongan Regency has several traditional foods, including nasi boran, wingko babat, soto lamongan, and pecel lele lamongan [5]. The most commonly found vendors are pecel lele sellers. They do not only sell pecel lele but also sell pecel ayam, tilapia, eggs, duck, and tofu-tempeh. All these dishes are fried before being served. The results of the observations show that the average sales capacity of pecel lele vendors is 30-100 servings per day. Almost all of these vendors repeatedly use cooking oil for frying pecel lele, which poses a significant health risk.

According to Ref. [6] states that the higher the water content in cooking oil, the lower the quality of the oil. The presence of water in the oil can trigger hydrolysis reactions that reduce the quality of the oil. Repeatedly used oil can degrade in physical and chemical quality (peroxide value and free fatty acids), making it unsuitable for consumption [7]. Research by Ref. [8] shows that the sample of cooking oil used by fried food vendors at Pujasera Market in Subang had color, smell, and peroxide values >10 mek O2/Kg, not meeting SNI 7709:2019 standards. Another study [9]

shows that 61% (14 out of 23) of cooking oil samples used by penyetan and fried food vendors on Perintis Kemerdekaan Street in Padang City had peroxide values above the SNI 2013 standard, indicating that the oil had deteriorated.

In this study, sampling was conducted on initial and used cooking oil to determine the quality of the oil used by pecel lele street vendors in the eastern region of Lamongan District. Therefore, it is necessary to conduct research on the physical and chemical quality analysis of initial and used cooking oil used by pecel lele vendors in Lamongan District, specifically in the eastern region of Lamongan District.

1.2. Literature Review

During the frying process, cooking oil undergoes various chemical reactions, including hydrolysis, oxidation, isomerization, and polymerization, resulting in volatile components. High-temperature heating will have a destructive thermal effect that can kill microbes and inactivate enzymes present in the food [4]. The quality of the oil used for repeated frying needs to be assessed.

Repeated use of cooking oil at high temperatures (160-180°C) with contact with air and water during the frying process will lead to complex degradation reactions in the oil and produce various reaction compounds [10]. These reactions include oxidation and hydrolysis. Hydrolysis can cause oil deterioration because of the water content in the oil. Oxidation can occur when the oil comes into contact with oxygen [11]. According to [12], oxidation can occur when the oil comes into contact with oxygen. This oxidation reaction will result in rancidity in the oil.

Oil quality tests can be determined by acid and peroxide values. The acid value is the amount of acid that can be neutralized by a base. The acid value is used to measure the amount of free fatty acids present in the oil. This determination can be carried out using the titration method. Fatty acids that are released from glycerol are referred to as free fatty acids [13]. According to [14], analyzing the quality of oil by testing peroxide value, free fatty acid content, and water content is sufficient to represent the oil's quality.

According to SNI 7709:2019, good quality oil should have a normal smell and color. The normal smell of cooking oil refers to the distinctive smell of palm oil, while the normal color ranges from yellow to pale yellow. Other quality standards include a water content not exceeding 0.1%; a maximum free fatty acid content of 0.3%; and a maximum peroxide value of 10 mek O2/kg.

According to [15], cooking oil that is repeatedly used can cause a decline in quality and even pose health risks. Cooking oil is typically used for 3-4 frying sessions. If reused repeatedly, the oil will turn dark in color, and the double bonds in unsaturated fatty acids will break, forming saturated fatty acids.

1.3. Research Objective

The objective of this study is to analyze the differences in chemical quality (water content, free fatty acids, peroxide value, TBA value) between initial and used cooking oil from pecel lele street vendors in the eastern region of Lamongan District

2. MATERIALS AND METHODS

2.1. Material and Tools

The materials used are a) raw materials: fresh cooking oil at the start of business, used cooking oil, and new bulk oil (comparison oil), and b) chemical analysis materials.: Natrium Tiosulfat 0.1 N, Asam Asetat Glasial, Klorofom, Larutan Kalium Iodida Jenuh, Indikator Kanji, Etanol, Indikator Fenolftalein (PP), Kalium Hidroksida 0.1 N, Reagen TBA, HCL 4M, Aquades, dan NaOH.

The equipment used for this research includes a UV-Visible spectrophotometer, distiller, analytical balance, dish, oven, water heater, desiccator, burette, Erlenmeyer flask, pipette, test tube, beaker, measuring cylinder, and stirrer.

2.2. Design of Experiment and Analysis

This research was conducted at the Food Analysis Laboratory of the Food Technology Study Program, Faculty of Engineering, UPN "Veteran" East Java. This study employed a survey research design using a cross-sectional study method. The sampling technique used was purposive sampling, which involves selecting samples based on specific criteria. The population in this study comprised all street vendors selling pecel lele in the eastern area of Lamongan District. The samples tested in this study were fresh and used cooking oil from pecel lele vendors who met the research criteria (13 vendors)

Data analysis in this study employed paired t-test with a significance level of 5%, comparing data with two different treatments on the same objects or samples.

2.3. Research Procedure

2.3.1. Chemical Analysis

Water Content

Water content analysis was conducted by heating the weighing bottle in an oven at 105°C for 30 minutes, then cooling it in a desiccator and weighing until a constant weight of the empty-dry dish was obtained. A 2-gram sample of cooking oil was weighed, then heated in an oven for 4 hours. The sample was cooled in a desiccator for approximately 15 minutes and re-weighed. Drying was continued until a constant weight was achieved [16].

Free Fatty Acids (FFA)

Analysis of free fatty acid content was performed by weighing a 5-gram sample of oil and placing it in a 250 ml Erlenmeyer flask. 50 ml of neutral 95% ethanol was added. The mixture was heated in a water bath until the temperature reached 50°C while stirring. It was then removed from heat and titrated with phenolphthalein indicator, adding 2-3 drops. Titration was carried out with 0.1 N NaOH solution until the color turned pink and remained for 30 seconds [16]

Peroxide Value

Peroxide value analysis was conducted by weighing a 5-gram sample of cooking oil and placing it in a covered Erlenmeyer flask. Then, 12 ml of chloroform and 18 ml of glacial acetic acid were added. The solution was shaken until all materials dissolved. After that, 0.5 ml of saturated potassium iodide solution was added, left for 1 minute. Then, add 30 ml of distilled water. Then,

add 0.5 ml of 1% amylum and immediately titrated with 0.1 N Na2S2O3 solution until the solution changed color from blue to blue began to disappear [16].

TBA Value

TBA value analysis was conducted by weighing a 10-gram sample of cooking oil into an Erlenmeyer flask. Then, add 2.5 ml of 4 M HCl until reaching pH 1.5 and then diluted to a total volume of 100 ml with distilled water. The sample was then distilled to obtain 50 ml of distillate. Then, the distillate was evenly mixed and 5 ml of distilled water was pipetted into a closed reaction tube and 5 ml of TBA reagent (0.2883 g TBA 100 ml-1 glacial acetic acid 90%) was added to the solution. After stirring, the mixture was heated in a boiling water bath for 35 minutes until a red-colored solution was obtained. The sample was immediately cooled, and absorbance was monitored at 538 nm using a spectrophotometer [3]

3. RESULT AND DISCUSSION

3.1. The pattern of cooking oil usage

Initial Condition of Cooking Oil

Based on Table 1, the highest percentage of initial conditions of cooking oil used by street vendors selling pecel lele in the eastern area of Lamongan District is mixed cooking oil (38.47%), followed by fresh cooking oil and leftover oil from yesterday, each with a percentage of 30.76%. Not all pecel lele vendors use fresh cooking oil at the beginning of their business day. According to [17], the reason for using cooking oil more than twice before discarding it is the vendors' perception that reused oil is still usable before its color turns black.

Frequency of Oil Requirement

The frequency of cooking oil requirement by pecel lele vendors shows that the highest percentage of daily oil requirement is 1-2 liters (53.84%), followed by vendors using 3-5 liters/day (38.47%), as shown in Table 1. Using cooking oil frequently ensures that the fried food is fully immersed. According to [18], it is common practice for people to deep fry their food to achieve a crispy texture.

Frying Duration

According to Table 1, the duration of a single frying session for dishes sold by pecel lele vendors in the eastern area of Lamongan District shows that the highest percentage is < 5 minutes (69.23%), followed by 5-8 minutes (30.76%). According to research [19], the highest percentage of frying duration for dishes sold by food vendors around Pasar Mengganti and Hulaan is 1-3 minutes (60%).

Frequency of Adding New Oil

According to Table 1, the frequency of adding new oil by pecel lele vendors in the eastern area of Lamongan District shows that the highest percentage is rarely or when the oil level decreases (46.15%), followed by adding new oil once (30.76%). According to research [20], vendors around Pasar Menganti Hulaan in Gresik only add new oil when the remaining oil volume for frying is low, at a rate of 8%.

Table 1. The pattern of use of cooking oil by the vendors

The consumption pattern of vendors	Quantity Frequency	Amount (%)
Places of Oil Purchase		
Traditional Market	8	61,53
Grocery Store	5	38,47
Total	13	100
Initial Oil Condition		
New	4	30,76
Leftover from Yesterday	4	30,76
Mixed	5	38,47
Total	13	100
Oil Requirement per Day		
1-2 liters	7	53,84
3-5 liters	5	38,47
5-8 liters	1	7,69
> 8 liters	0	0
Total	13	100
Frying duration		
< 5 minute	9	69,23
5-8 minute	4	30,76
> 8 minute	0	0
Total	13	100
Addition of New Oil		
1 time	4	30,76
2 times	0	0
> 2 times	0	0
Rarely/if reduced	6	46,16
Never	3	23,07
Total	13	100
Frequency of changing oil		
Never change	9	69,23
After it turns dark	4	30,76
After the 3rd frying	0	0
After the 5th frying	0	0
After the 10th frying	0	0
Total	13	100
Handling of used oil		
Discarded	3	23,07
Sold to collectors	6	46,16
Stored for use the next day	4	30,77
Total	13	100

Frequency of Oil Replacement

According to Table 1, the frequency of replacing cooking oil shows that the highest percentage is vendors who never replace their cooking oil from opening to closing (69.23%), followed by those who replace it after it turns dark or black (30.76%). According to [8], people tend to use cooking oil until it runs out, leave unusable oil, or replace it when it turns black.

Handling of Used Cooking Oil

According to Table 1, the highest percentage of handling used cooking oil is collecting it to sell to collectors (46.16%), followed by storing it for use the next day (30.77%), and disposing of used cooking oil (23.07%). This occurs because cooking oil used is not always finished in one day, resulting in leftover used oil or waste cooking oil. According to [2], the more frequently palm oil is used, the higher the peroxide value increases significantly.

3.2. Chemical Quality Analysis

Chemical quality analysis conducted on initial and used frying oil by street food vendors of fried catfish includes analysis of moisture content, free fatty acids, peroxide value, and TBA (Thiobarbituric Acid) value.

3.2.1 Water Content

Water content is the amount of water present in oil [9]. The results of water content testing (Table 2) show that the water content in the cooking oil used by pecel lele vendors in the eastern area of Lamongan District at the beginning of their business day ranges from 0.10% to 0.49%, with an average water content of

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0.22%. The highest water content in cooking oil at the beginning of the business day was found in sample codes H1 (0.32%) and L1 (0.39%), while the highest water content in used cooking oil was found in sample codes B2 (0.61%) and K2 (0.50%), exceeding the standard water content value of cooking oil according to SNI 7709:2019. The best quality of initial use cooking oil was in sample code B1, with the lowest water content of 0.10%. Meanwhile, sample code A2 had the best quality of used cooking oil with the lowest water content (0.14%), which meets SNI 7709:2019.

Tabel 2. Results of the analysis of water content in the cooking oil samples from vendors

Code Sample (Initial)*	Water Content (%)	Ket	SNI 7709:2019	Code Sample (End)**	Water Content	Ket
A1	0,12	MS		A2	0,14	MS
B1	0,10	MS		B2	0,61	TM
C1	0,11	MS		C2	0,43	TM
D1	0,15	MS		D2	0,23	TM
E1	0,25	TM		E2	0,39	TM
F1	0,23	TM	Maks.0,1%	F2	0,39	TM
G1	0,15	MS		G2	0,39	TM
H1	0,33	TM		H2	0,44	TM
I1	0,31	TM		I2	0,45	TM
J1	0,31	TM		J2	0,25	TM
K1	0,13	MS		K2	0,50	TM
L1	0,42	TM		L2	0,52	TM
M1	0,15	MS		M2	0,37	TM
Avarage	0,21%				0,39%	

Explanation: TM = does not meet SNI requirements, MS = meets SNI requirements
*initial oil upon opening the stall ** used oil

High water content is caused by hydrolysis reactions on the triglyceride bonds of cooking oil, and poor storage conditions in open containers can absorb moisture from the air [21]. High water content can trigger hydrolysis reactions in cooking oil. The amount of water content is influenced by several factors, including frying temperature and the amount of food fried. High frying temperatures can cause water vapor to form around the cooking oil, leading to the hydrolysis of triglyceride bonds in the oil [22].

3.2.2 Free Fatty Acids (FFA)

Tabel 3. Free Fatty Acid (FFA) content in the cooking oil samples

Code Sample (Initial)*	ALB	Ket	SNI 7709:2019	Code Sample (End)**	ALB	Ket
A1	0,34	MS		A2	0,62	TM
B1	0,22	MS		B2	0,76	TM
C1	0,21	MS		C2	0,88	TM
D1	0,70	TM		D2	1,01	TM
E1	0,52	TM		E2	0,63	TM
F1	0,35	MS	Maks.	F2	0,92	TM
G1	0,32	MS	0,3%	G2	0,62	TM
H1	0,65	TM		H2	0,93	TM
I1	0,42	TM		I2	0,57	TM
J1	0,61	TM		J2	0,42	TM
K1	0,35	MS		K2	0,67	TM
L1	0,59	TM		L2	0,79	TM
M1	0,33	MS		M2	0,76	TM
Avarage	0,43%				0,74%	

Explanation: TM = does not meet SNI requirements, MS = meets SNI requirements
*initial oil upon opening the stall ** used oil

Free Fatty Acids (FFA) are the main components of oil that undergo hydrolysis, which is the breakdown of fat molecules into free fatty acids and glycerol. The results of free fatty acid content testing (Table 3) show that 73.07% (19 out of 26) of the initial and used oil samples tested did not meet the requirements set by SNI 7709:2019. Only 26.92% (7 out of 26) of the samples met the requirements set by SNI 7709:2019 with free fatty acid levels not exceeding 0.3%. However, some samples still meet the SNI 7709:2019 standard.

In terms of FFA levels, sample code D1 had the poorest initial cooking oil quality with the highest FFA level (0.70%). This value significantly exceeds the maximum limit (0.3%) set by SNI 7709:2019. Meanwhile, the best quality of initial cooking oil used by pecel lele vendors in this study in terms of free fatty acid content was found in cooking oil with sample code C1, which had the lowest free fatty acid content of 0.21%.

In terms of FFA levels, sample code D2 had the poorest quality of used cooking oil with the highest FFA level (1.00%). This value far exceeds the maximum limit (0.3%) set by SNI 7709-2019. Meanwhile, sample code J2 had the best quality of used cooking oil with the lowest FFA level (0.42%).

High levels of free fatty acids are caused by hydrolysis reactions that break triglycerides into free fatty acids and glycerol. Subsequently, glycerol forms acrolein compounds that cause throat irritation [23]. According to [2], high levels of free fatty acids are caused by using high temperatures during frying. The higher the free fatty acid content, the greater the damage to the oil caused by the increased number of hydrolyzed triglyceride molecules. Using temperatures >250°C during frying will generate water vapor around the cooking oil, causing H2O molecules to bond with hydrolyzed fatty acids to form free fatty acids [24]. The used cooking oil with sample code D2 had the highest free fatty acid content due to continuous heating. Based on observations, vendors do not turn off the stove but leave it on with a low flame.

3.2.3 Peroxide Value

Peroxide value is one of the parameters used to determine the quality of cooking oil by measuring the amount of peroxides formed in the oil as a result of lipid oxidation by oxygen in the air. The results of peroxide value testing (Table 4) show that 84.61% (22 out of 26) of the initial and used oil samples tested did not meet the requirements set by SNI 7709:2019. Only 15.38% (4 out of 26) of the samples met the requirements set by SNI 7709:2019 with peroxide values not exceeding 10 meq O2/kg. The peroxide values in the cooking oil used by pecel lele vendors in the East Timur District of Lamongan at the start of their operations ranged from 6.82 to 34.63 meq O2/kg, with an average peroxide value of 18.35 meq O2/kg.

Tabel 4. Results of the Peroxide Value analysis of the merchants' oil

Code Sample (Initial)*	Peroksida	Ket	SNI 7709:2019	Code Sample (End)**	Peroksida	Ket
A1	9,96	MS		A2	28,44	TM
B1	6,82	MS		B2	30,12	TM
C1	7,88	MS		C2	31,74	TM
D1	25,73	TM		D2	30,39	TM
E1	20,85	TM		E2	26,06	TM
F1	19,43	TM	Maks.	F2	22,44	TM
G1	11,08	TM	10 mek	G2	29,37	TM
H1	32,44	TM	O_2/Kg	H2	37,66	TM
I1	21,89	TM		I2	27,00	TM
J1	34,63	TM		J2	26,08	TM
K1	11,25	TM		K2	30,37	TM
L1	25,00	TM		L2	26,59	TM
M1	10,00	MS		M2	35,86	TM
Avarage	18,23				29,39	

Explanation: TM = does not meet SNI requirements, MS = meets SNI requirements
*initial oil upon opening the stall ** used oil

In terms of peroxide value, sample code J1 had the poorest quality of initial cooking oil with the highest peroxide value (34.63 meq O2/kg). Meanwhile, sample code B1 had the best quality of initial cooking oil with the lowest peroxide value (6.82 meq O2/kg), which meets SNI 7709:2019 standards.

In terms of peroxide value, sample code H2 had the poorest quality of used cooking oil with the highest peroxide value (37.66 meq O2/kg). This value significantly exceeds the maximum limit (10 meq O2/kg) set by SNI 7709-2019. Meanwhile, sample code

G2 had the best quality of used cooking oil with the lowest peroxide value (22.44 meq O2/kg). However, this value still exceeds the maximum limit set by SNI 7709-2019 and is higher than the study [8], which reported a minimum peroxide value of 14.6 meq O2/kg for used cooking oil from fried food vendors at Pasar Pujasera Subang.

According to Ref. [16], the increase in peroxide content is due to oxidation processes resulting from fats being in contact with oxygen in the air. Factors influencing high peroxide values include exposure to oxygen. According to [3], exposure to oxygen from the free air can react with triglyceride bonds in cooking oil, leading to oxidation reactions. Additionally, more frequent frying increases peroxide content due to thermal oxidation reactions during frying [18]. Sample code H2 was known to operate for 7 hours a day, selling between 30-50 servings.

3.2.4 TBA Value

Thiobarbituric Acid (TBA) number is used as a method to indirectly measure the level of free radicals by measuring lipid oxidation products such as malondialdehyde (MDA). The low TBA number in the bulk oil sample used as a control is indicated by the absence of color change in the test solution.

The results of the TBA test (Table 5) show that the TBA values for initial-use oils range from 0.14 to 0.75 mg MDA/kg. These values indicate that some vendors use oil repeatedly from the start, resulting in higher TBA values. Meanwhile, for used oils, the TBA values range from 0.24 to 0.86 mg MDA/kg. According to [7], the repeated use of oil leads to its rancidity, thus increasing its TBA content.

In terms of TBA values, sample code H1 exhibits the poorest quality of initial-use frying oil with the highest TBA value (0.75 mg MDA/kg). Conversely, sample code B1 demonstrates the best quality of initial-use frying oil with the lowest TBA value (0.14 mg MDA/kg). This value is slightly higher compared to research [25], which states that fresh unused frying oil has a TBA value below 0.1 mg MDA/kg.

Tabel 5. Results of the TBA number analysis of the oil from the merchants

Code Sample (Initial)*	TBA Value	Code Sample (End)**	TBA Value
A1	0,22	A2	0,41
B1	0,14	B2	0,24
C1	0,23	C2	0,93
D1	0,37	D2	0,55
E1	0,49	E2	0,78
F1	0,67	F2	0,80
G1	0,19	G2	0,69
H1	0,75	H2	0,86
I1	0,54	I2	0,62
J1	0,67	J2	0,49
K1	0,15	K2	0,83
L1	0,71	L2	0,61
M1	0,61	M2	0,58
Avarage	0,44		0,65

Explanation: *initial oil upon opening the stall ** used oil

Regarding TBA values, sample code H2 represents the poorest quality of used frying oil with the highest TBA value (0.86 mg MDA/kg). This TBA value is higher compared to research [25], which reported values ranging from 0.60 to 0.70 mg MDA/kg for oil heated for 72 hours at 180°C without frying food, resulting in minor oxidation. In contrast, sample code B2 represents the best quality of used frying oil with the lowest TBA value (0.24 mg MDA/kg).

According to [26], heating oil at high temperatures and repeated use can produce aldehydes, ketones, and aromatic compounds with rancid odors. Frying at high temperatures with air and moisture from food ingredients causes oil to deteriorate. The National Standardization Body (1991) sets the maximum limit for oil rancidity at 3 mg MDA/kg. However, the safe limit for free radicals in each human body varies, depending on the body's ability to manage them [27].

3.3. Differences in the chemical quality of initial and used oil used by vendors

The quality difference test between initial-use and used cooking oils used by street vendors selling fried catfish in the East Region of Lamongan District was conducted using a t-test with a significance level of 5% (0.05) using SPSS version 27.

Tabel 6. Results of the T-test analysis for the difference in quality between fresh and used cooking oil

Parameter Test	T	Sign
Water Content	3,662	0,003
Free Fatty Acid (FFA) Content	4,830	0,001
Peroxide Value	3,914	0,002
TBA Value	2,544	0,026

Based on the analysis results in Table 6, the T-table value obtained is 2.1788 using df n-1=13-1=12. From the t-test analysis of the four parameters (moisture content, free fatty acids, peroxide value, TBA value), it is found that the t-test value is greater than the T-table value. Therefore, it can be concluded that there is a difference in the quality of initial use and cooking oils used by street vendors selling fried catfish in the East Region of Lamongan District.

4. CONCLUSION

The results of this study can be summarized as follows: street vendors selling fried catfish in the East Region of Lamongan District predominantly use bulk cooking oil (100%), use mixed oil (a combination of used and new oil) from the start of their operations (38.47%), use 1-2 liters of cooking oil per day (53.84%) with each frying session lasting less than 5 minutes, never change the oil from opening to closing time (69.23%), add new oil when the remaining oil is low (46.16%), and collect used cooking oil to sell to collectors (46.16%).

The chemical quality analysis results of 13 initial cooking oil samples showed that the percentage that did not meet SNI 7709:2019 standards for water content was 46.15%, free fatty acids were 46.15%, and peroxide values were 69.23%. For used cooking oil samples, the percentages that did not meet SNI 7709:2019 standards for water content were 92.30%, free fatty acids were 100%, and peroxide values were 100%. The average TBA value for all initial-use cooking oil samples was 0.44 mg MDA/kg, and for used cooking oil samples was 0.65 mg MDA/kg, both higher than the reference sample (0.15 mg MDA/kg). The t-test results showed that there were quality differences between the initial and used cooking oil used by street vendors selling pecel lele in the eastern region of Lamongan District.

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