

## CHARACTERISTICS OF OIL USED IN FRYING PEANUTS, CASSAVA AND MACKAREL TUNA

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### ABSTRACT

The characteristics of used frying oil that are carried out repeatedly using high temperatures and with various types of frying materials will produce new types of oil characteristics, either the appearance and disappearance of certain types of chemical components or changes in the physical properties of frying oil. This study aims to determine the characteristics of cooking oil used in frying peanuts which have high fat content, high carbohydrate content of cassava and mackarel tuna which have high protein content. Samples of used oil were obtained from the use of pure oil from palm oil and then the 3 different types of material were fried with 10 frying repetitions. The used frying oil was then visually observed and analyzed for the number of peroxides, free fatty acids, and moisture content, color test, amount of oil lost and its fatty acid profile. In addition, the amount of oil lost due to frying was observed. The results of the observation of physical properties showed that the smell of oil became rancid, the taste of the oil became bitter and the color turned black. The results of chemical analysis showed that the highest peroxide number was 50 meq / kg, the highest ALB was 4.35%, and the highest moisture content was 3.21%, the oil color changed to brown to black, the highest amount of oil lost due to frying was cassava frying oil, namely 58.4%. The fatty acid profile of used frying oil has been obtained and there is a decrease in the percentage, the appearance of stearic acid and the loss of heptadecanoic fatty acids in the used cooking oil for peanuts, cassava and mackarel tuna.

**Keywords:** Peanut, Cassava, Mackarel tuna, Used cooking oil, Fatty acid profile.

### INTRODUCTION

Used cooking oil is cooking oil that is used repeatedly more than twice by using high temperatures, during frying the oil will immediately mix with the outside air, causing an oxidation reaction (Sartika, 2009). Used cooking oil is produced in large quantities, usually from frying fish, frying cassava and

seeds. For example, frying fish such as tuna which is done in households or restaurants, cassava frying, namely fried cassava or chips and frying seeds, namely frying peanuts or peas.

The frying process using high temperatures and is carried out repeatedly will result in changes to the oil component which causes the oil to become damaged and produces a rancid odor due to the oxidation of aldehyde compounds, ketones and aromatic compounds (Mariod et al, 2006). Repeated use of oil also results in changes in the composition of the oil medium due to polymerization of unsaturated fatty acids.

The use of cooking oil repeatedly in Indonesia is still relatively high, namely the use of cooking oil more than twice, reaching 24% (Ilmi et al, 2015). This causes oil to experience damage in addition to contact with water, air and metals (Prastagani, 2016). Damage to the oil used for the food frying process will also affect the results of the fried ingredients, so that when the oil is consumed along with the fried food, automatically the damaged oil will also be consumed. High temperatures and oxygen contact result in an increase in free fatty acids which are harmful to the body when consumed. The increase in free fatty acids in the body results in *systemic inflammation* which is characterized by the appearance of *interleukin-6* and C-reactive protein which results in heart failure and sudden death (Mozaffarian et al, 2006). Increased fatty acids, repeated heating of the oil will form trans fatty acids (HY Fan et al, 2013).

According to Astuti (2003), frying tilapia underwent a change in chemical properties in the frying pan more than twice as there was a high change in the peroxide number, which became 12 meq / kg. Frying chicken also undergoes physiochemical changes, namely damage occurs in frying 16-51 times with the same oil without adding new oil (Staff of the Laboratory for Basic Chemistry and Analytical Chemistry, 2012). besides frying using cassava and other types of grains above ten times, it will also have a significant effect on the physiochemical content of used frying oil, this is because the use of high temperatures and contact with air will result in an oxidation reaction so that the value of free fatty acids in oil is also will increase.

In this study, observations were made of used frying oil from different types of materials with the highest chemical content, with the aim of knowing the characteristics of cooking oil from frying peanuts with high fat content, cassava with high carbohydrate content and mackarel tuna with high protein content

## EXPERIMENTAL SECTION

### Materials

The main ingredients used are pure cooking oil of palm oil, 1 kg of peanuts, 1 kg of tuna and 1 kg of cassava with the use of 10 times the frying oil for each raw material. Other materials used include methanol, 98% H<sub>2</sub>SO<sub>4</sub>, chloroform, aquadest, Na<sub>2</sub>SO<sub>4</sub>, KOH and filter paper.

### Instrumentation

The equipment used was a 250 ml erlenmeyer, 250 ml beaker, 25 ml measuring cup, aluminum cup, burret, hunterlab, oven, separating funnel, funnel, hot plate, dropper pipette, one neck flask, analytical

scales, and *Gas Chromatography Mass Spectrometry*. (GCMS) type QP-2010 Ultra, column oven temperature 60 °C, *injection* temperature 200 °C, *injection split*, linear *velocity* mode, *pressure* 14.4 kPa

### Procedure

The research was conducted at the Laboratory of Agricultural Product Engineering and Technology, Faculty of Agricultural Technology, Andalas University, Padang City.

Pure cooking oil 500 ml dimasak right in the container (cauldron) turn the fire then wait 10 minutes until the oil temperature of 150 °C then prepared and cleaned peanuts, tuna, and cassava. After the oil reaches a temperature of 150 °C, put the cleaned peanuts, fry for about 7-10 minutes until cooked with a brownish yellow color, drain the beans and repeat the frying for the other beans for up to 10 repetitions, after that, cool and filter the used frying oil. for analysis.

The next frying process is for cassava and mackerel with the same process as the peanut frying process, but each frying cassava and tuna requires a different time from frying peanuts until the used cassava frying oil and tuna frying oil are obtained.



**Fig.1.** Image of raw cuttings (a) peanuts, (b) cassava (c) tuna.

### Parameters observed

The parameters observed raw materials in cooking oil pure palm oil that is visual, peroxide value, free fatty acids, moisture content, color test and the fatty acid profile, k emudian having obtained a cooking oil analysis on waste cooking oil that is visual, peroxide value, fatty acids free, moisture content, color test, the amount of oil lost and the acid profile of the lesion k

### Observation of the physical and chemical properties of used cooking oil

Visual observation uses a qualitative descriptive test which is assessed through the use of the sense of sight, the sense of smell and the sense of taste (Soekarto, 1985), the number of peroxide, the number of free fatty acids (ALB), the water content is analyzed using the SNI 01-7709-2019 method (BSN, 2019 and BSN, 1995) regarding the quality requirements for cooking oil.

Color test using a hunterlab tool, put oil in a glass sample container as much as 5-7 ml then put in a tool to be read using light, the results of the color readings are indicated by the results L, a \*, b \*.

The method of analysis of the fatty acid profile used has the principle of converting fatty acids into their derivatives, namely methyl esters. So that it can be detected by chromatography. Take 20 mg of the oil sample and put it in a 250 ml erlenmeyer with a lid, then add 4 ml of solvent with the ratio,

Methanol (1.7 ml): 98% (0.3 ml) H<sub>2</sub>SO<sub>4</sub>: Chloroform (2 ml). Close the erlenmeyer tightly, then homogenize using a vortex for 15 minutes, then heated using a hot plate at 90 °C for 90 minutes, finished heating, cooled the erlenmeyer sample to room temperature for ± 5-6 hours. After it cooled, then added 1 ml of distilled water and then homogenized using vortex for ± 1 minute. Put in a separating funnel, let stand for a while until 2 layers are formed, the bottom layer containing Fatty Acid Methyl Ester (FAME) is separated into another empty erlenmeyer, then 2 ml of Na<sub>2</sub>SO<sub>4</sub> is added until it does not dissolve. After that it is filtered using filter paper, then the filtrate is transferred into a closed erlenmeyer and the sample is ready for GC-MS analysis.

## RESULTS AND DISCUSSION

The results of the analysis of the characteristics of used cooking oil from three different types of raw materials.

Results and discussion contain findings of research and their discussion. All findings must be supported by sufficient data. This part must answer hypothesis of the research stated in the Introduction. The actual results and discussion, supported by schemes, figures, graphs, tables, reactions, and equations. Figures, charts, tables, schemes, and equations should be embedded in the text at the point of relevance. All Tables and figures must have a title or caption and a legend to make them self-explanatory. In addition, the equation should be written using the equation editor.

### Visual analysis of used frying oil

Tables are numbered consecutively with Arabic numerals. The title should immediately follow the table number at the head of the table. Tables should appear within the manuscript when mentioned and should not be grouped at the end. Abbreviations and linear chemical formulas may be used in headings and columns of tables.

Each table must have a brief (one phrase or sentence) title that describes the contents. The title should be understandable without reference to the text. Details should be put in footnotes, not in the title. Tables should be used when the data cannot be presented clearly in the narrative, when many numbers must be presented, or when more meaningful inter-relationships can be conveyed by the tabular format. Tables should supplement, not duplicate, the information presented in the text and figures. Tables should be simple and concise.

**Table 1.** The results of the visual analysis of used frying oil from three different ingredients.

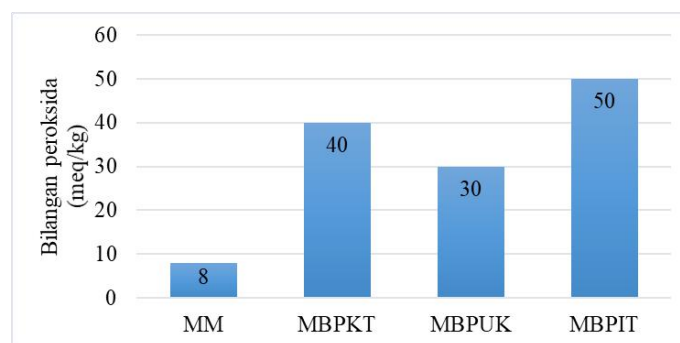
Parameter	Variable			
	MM	MBPKT	MBPUK	MBPIT
Aroma	Normal	Peanuts	Normal	Rancid
Taste	Normal	Bitter	Normal	Bitter
Color	Yellow	Yellow	Yellow	Black

Information: pure oil (MM), used peanut frying oil (MBPKT), cassava frying oil (MBPUK), tuna frying oil (MBPIT)

Repeated use of palm oil at temperatures above 100 °C results in changes to the oil, both chemical and physical changes. The three raw materials used in this frying pan, the biggest change occurred in the used tuna frying oil, changes from the smell that appears to rancid, the taste becomes bitter and the color turns black, this is influenced by the high water content.

According to the results of Arianing's research (Arianing, 2018), it was found that the results of the used cooking oil had a brownish yellow color and had no aroma, these results were almost the same as the used groundnut and cassava cooking oil obtained but different from the used fish frying oil. tuna, this is due to different types of fried raw materials so as to produce different visuals.

### The peroxide number



**Fig. 2.** Peroxide number of pure oil (MM), used peanut frying oil (MBPKT), cassava frying oil (MBPUK), tuna frying oil (MBPIT)

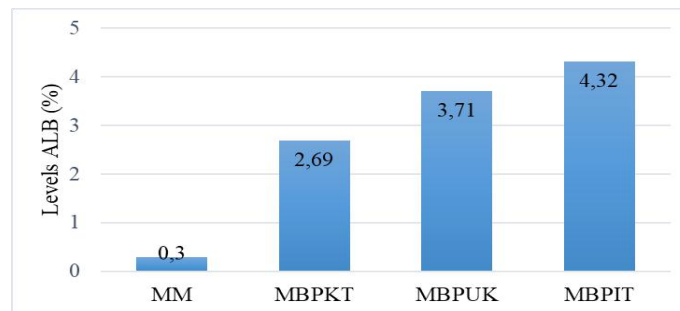
The peroxide number obtained from the three raw materials used is 30-50 meq / kg with an average of the three raw materials being 40 meq / kg, this shows that the peroxide number is very high in the used oil in the sample fryer, while the value of the peroxide number is very high. The initial raw material for pure cooking oil is only 8.0 meq / kg, this indicates that the oil has been damaged with other characteristics of discoloration and a rancid aroma. Peel on used frying oil is clarified with the maximum limit of the cooking oil peroxide number stipulated in SNI Regulation 01-7709-2019 which states that the maximum content of the peroxide number for cooking oil is 10 meq / kg. When compared to the three samples of used frying oil in the table above, the value of the highest peroxide number is found in mackarel tuna, this is evidenced by the final form of the oil produced is very black, has a rancid and dirty aroma.

The saturated fatty acid content contained in peanuts and mackarel tuna also triggers a high oxidation rate, so that when the oil comes into contact with air, the oxidation rate is very fast and makes the oil quality decrease drastically in the used cooking oil of peanuts and mackarel tuna. In addition, the impact of the damage to the oil also affects the quality of the frying products, which initially the food has good nutritional value, but if it is fried using cooking oil that already has a high peroxide number, the damaged oil is automatically carried away by the food that comes into contact with the oil. Yuarini et al (2018) obtained the results of research on the peroxide number of 13.27% on street food vendors who are on the side of the road, this value also exceeds the SNI limit for cooking oil, when compared to the used cooking oil for three raw materials used in this figure. far below it, this is clearly different because the

types of raw materials used when frying are different, starting from the water content, the dirt content which makes the oxidation number of the fried samples very high.

### Free fatty acid levels

In Figure 4. Shows a graph of free fatty acids in used cooking oil for peanuts, cassava and mackerel.



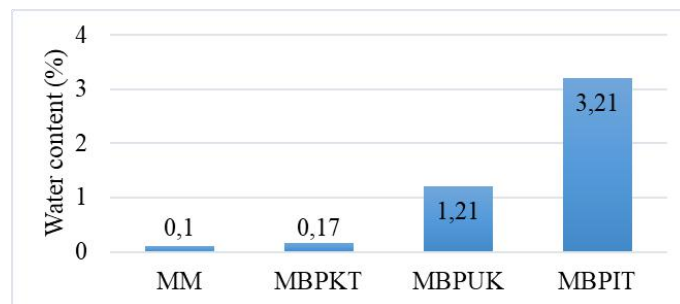
**Fig. 3.** Pure oil-free fatty acids (MM), used peanut frying oil (MBPKT), cassava frying oil (MBPUK), tuna frying oil (MBPIT)

The free fatty acids obtained from the three used frying oils are 2.69-4.32% with an average of 3.57%, this implies that there is an increase from the original raw cooking oil used where the ALB value is 0,3%. The three used frying oils above have a very high value that exceeds the Indonesian National Standard (SNI) regarding the quality requirements for cooking oil, which is a maximum of 0.3%.

The results of the ALB analysis above show that the occurrence of oil damage due to the hydrolysis reaction in which the high water content in the three raw materials is accelerated by the frying temperature of the oil, so this makes the ALB increase rate fast, this is evident in the ALB of used tuna frying oil, which of the three The highest water content for fried raw materials was found in tuna, namely 70.4%.

The quality of used frying oil is health unfit for consumption, if consumed, it will affect the health of the body such as the occurrence of itching in the throat and result in *systemic inflammation* which is characterized by the appearance of *interleukin-6* and C-reactive protein which has an impact on heart failure and sudden death (Mozaffarian et al, 2006). Therefore it is necessary to maintain foods that are fried in used oil which have a high content of free fatty acids. The results of the free fatty acid number obtained in this study were higher than the research conducted by Suroso (Suroso, 2013) with the free fatty acid number of 0.64% in the black used cooking oil research obtained from the catfish pechel seller, this difference is influenced by the type of raw material. which is used when frying the raw material for tuna, cassava has a much higher moisture content than the raw material for frying chicken pechel.

### Water content

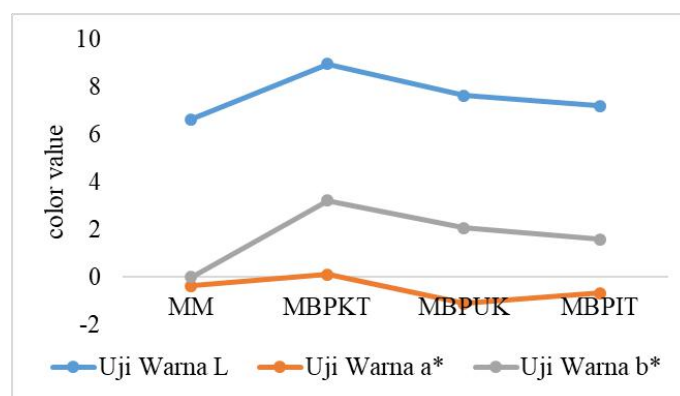


**Fig. 4.** Water content of pure oil (MM), used peanut frying oil (MBPKT), cassava frying oil (MBPUK), tuna frying oil (MBPIT)

The water content in the graph above shows an increase in the moisture content of peanut, cassava and tuna oil. The increase is due to the water content of the fried ingredients, the water content of groundnut 6-8% (BSN, 1995), minimal cassava (55-65%) (Sopianti et al, 2017) and 63.40% fresh fish (Kaiang et al, 2016). So that the water in the raw material affects the level of water content produced, according to SNI the maximum water content in oil is 0.1%, besides that the high water content in the used oil above will affect the free fatty acids so as to accelerate the hydrolysis reaction.

The water content in food ingredients greatly affects the frying process, because water is one of the negative impacts on oil, because when water comes into contact with oil which is influenced by high heat, there will be a chemical reaction, namely hydrolysis.

### Used cooking oil color test value



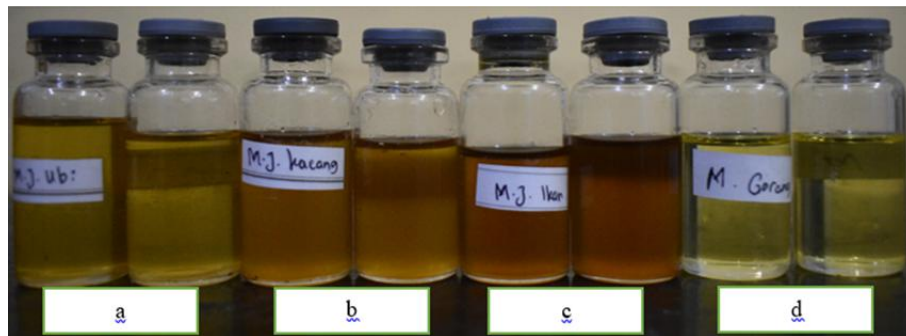
**Fig. 5.** Color test of pure oil (MM), used peanut frying oil (MBPKT), cassava frying oil (MBPUK), tuna frying oil (MBPIT)

The colors identified by using CIE L \* a \* b \* with the criteria for the L \* value show white, gray and black acrobatic colors, the a \* value shows a red color and the b \* value tends to be yellow (Purwani and Muwakhida, 2006). In the graph in Figure 5 above, it explains the dark color L \* value with the L \*



number the higher it shows the oil color is getting whiter, on the other hand, if the L \* number gets smaller, the oil gets blacker. Tongkol fish oil has a darker color than cassava and peanut oil, this is influenced by the type of raw material that is fried in tuna. Fried ingredients break down more, besides that the black fish also causes the color of used cooking oil to turn black. Unlike the case with the lighter color of the raw material for cassava and peanuts, it can be seen in Figure 6.

Color is also an indicator of oil damage, damaged oil is identical to brown to black, which is due to contamination from the raw materials used to react directly with oil, which causes the color of raw materials to move and mix with used residual oil. frying. If the oil that has changed color is used for frying other foodstuffs, the color will also move to fried food ingredients.



**Fig. 6.** Figure a) oil used for frying cassava (MBPUK), b) oil from frying peanuts (MBPKT), c) oil used for frying tuna (MBPIT), d) pure oil (MM),

### **The amount of oil used in the frying process**

The cooking oil used in frying peanuts, cassava and mackarel tuna is 500 ml of pure cooking oil, which leaves 311 ml of peanut cooking oil (37.8%), 208 ml of cassava (58.4%). and tuna 367 ml (26.6%). Based on these data, the amount of used oil was 37.8% in frying peanuts, 58.4% in cassava and 26.6% in mackarel tuna. The oil that is used up is 26.6% -58.4% an average of 40.9% with the most used percentage of cooking oil is cassava, this is due to the time consuming cassava frying takes a long time and the oil absorption of the cassava. after frying is also high.

High absorption of cooking oil in raw materials is not a good thing when consumed, especially if the oil content is damaged when consumed, it will have an impact on health, the things that cause this to happen are the types of raw materials that are not dry, fried, raw materials that are too contains high water, and the temperature of cooking oil is too low, namely a temperature of  $<180^{\circ}\text{C}$ , so that when the ingredients are not dry, the oil will easily enter the pores of the fried ingredients.

Aminah's research results (Aminah and Iswono, 2010) explain that the amount of used oil in fried food traders is by adding new oil about 1-2 times during frying for 2-3 hours up to 10-20 repetitions. The higher the repetition in the frying process and the higher the amount of oil used up is proportional to the increase in the number of repetitions in the frying pan.



### Fatty acid profile

In Table 2. The following are the results of testing the fatty acid profile of cooking oil using GCMS on three used cooking oil raw materials from peanuts, cassava and mackarel tuna.

**Table 2.** Results of fatty acid profile analysis

Types of Fatty Acids	Variable (%)			
	MM	MBPKT	MBPUK	MBPIT
Hexanoic acid	0.02	-	-	-
Octanoic acid	0.28	0.44	0.89	0.33
Azelic acid	-	0.04	-	-
Decanoic acid	0.34	0.31	1.98	0.31
Lauric acid	-	2.34	3.38	3.04
Myristic acid	9,14	6.52	5.98	7.96
cis-10-pentadecanoate	-	0.17	-	-
Palmitoleic acid	0.56	0.98	1.79	1.6
cis-10-heptadecanoate	0.32	0.54	0.51	0.68
Oleic acid	29.18	29.13	21.11	28.23
Stearic acid	-	18.12	20.57	18.42
9-hexadecanoic acid	1.65	0.92	0.67	1.26
Palmitic acid	28.80	30.43	21.68	28.99
Hexadecanoic acid (15-meth)	0.96	0.57	0.89	0.71
Oxacyclohecadecanoic acid		2.93	-	-
Heptadecanoic acid	17.62	0.05	-	-
8-heptadetechnoic acid	0.54	-	-	-
7-octadecenoic acid	-	-	-	0.65
9-octadecenoic acid	-	1.27	1.81	3.40
9,12-octadecenoic acid	0.12	0.48	-	0.33
10- octadecenoic acid		0.78	-	-
10-nonadecanoic acid	0.05	-	-	-
Eicosatrienoic acid 7,10,13	0.04	-	-	-
11- eicosanoic acid	1.59	-	-	-
Eicosanoic acid	3.81	1.30	-	1.58
Docosanoic acid	0.55	0.27	0.28	0.27
Cholesta-3,5-diene	-	-	-	0.10

Information: pure oil (MM), used peanut frying oil (MBPKT), cassava frying oil (MBPUK), tuna frying oil (MBPIT)

The fatty acid profile produced from used cooking oil for frying peanuts, cassava and tuna, produces data and the percentage of different types of fatty acids, there are fatty acids that have decreased in percentage and some have increased in percentage, some have lost their species. fatty acids and there are also emerging types of new fatty acids from used frying oil.

Decanoic acid is a saturated fatty acid in pure coconut oil raw material with a content of 0.34%. This figure is not much different when compared to the weak acid content in the used cooking oil for peanuts and mackarel tuna, but the percentage number increases in the used frying oil. Cassava increased by 1.64%, this indicates the high level of saturated fatty acids in peanuts with decanoic fatty acids.

Lauric acid is a medium chain saturated fatty acid which is composed of 12 atoms C. This type of fatty acid is mostly contained in coconut oil but very little in palm oil, only about 0.2%, but in testing the fatty acid profile of used peanut frying oil, Cassava and mackarel tuna have increased from 2.14 to 3.18%, this indicates the transfer of fatty acids in fried raw materials (Suismono et al, 2015).

Myristic acid is a type of saturated fatty acid that is composed of 14 C atoms. This acid can be found in several types of essential oils, for example in the nutmeg plant. In refined palm oil, myristic acid has a percentage of 9.14% but there is a decrease in the percentage after it is used for frying peanuts, cassava and tuna this is due to a change in the type of myristic acid to other fatty acids, because it is caused by high heat. , water and air make changes to C atoms and double bonds when oil is used in frying.

Palmitoleic acid is a type of fatty acid that has a double bond, the initial content of this fatty acid is only 0.56% in pure oil used for frying, but the former cassava oil has a high percentage increase, this is due to the effect of palmitoleic acid content. In cassava which is transferred to used frying oil, the same thing also occurs in the used cooking oil for peanuts and mackarel tuna, although the percentage is not as big as the oil used for frying cassava (Ketaren, 2008).

Oleic acid has a fairly large percentage in refined palm oil but has decreased in the used cassava frying oil due to the transfer of fatty acids and turns into other fatty acids whose percentages increase such as de-decanoic acid and lauric acid. Meanwhile, the used oil for frying peanuts and tuna did not change much in percentage.

Stearic acid is a type of saturated fatty acid that can be found in animal oil or vegetable oil, the oil used in frying peanuts, cassava, and mackerel has a very high increase, where there is an increase of up to 20%, this indicates that the oil in the ingredients The raw material has shifted to used frying oil, because peanuts, cassava and tuna contain quite high stearic acid (Ketaren, 2008).

Palmitic acid is a type of fatty acid that is easily found in vegetable oils such as coconut and palm oil. The pure cooking oil used contained 28.80% in the used cooking oil of peanuts, an increase of 1.63%, this was due to the fact that peanuts had a high palmitic acid content of 12.5% (BPTAKU, 2014). It is different from used cassava frying oil which has decreased the percentage because cassava does not contain palmitic acid, then palmitic acid is converted into other types of fatty acids because several types of fatty

acids in used cassava cooking oil have increased and in used tuna frying oil. the percentage does not change too much (Sargiman, 2015).

Heptadecanoic acid is a saturated fatty acid which has an odd double fatty acid, namely C17 in pure cooking oil which has a high percentage of 17.62% but has decreased until it is no longer contained in the oil content used in frying peanuts, cassava and mackarel tuna. This indicates that there is the influence of the frying process which makes these fatty acids turn into other types of fatty acids due to the interaction of oil with water, heat and air.

9-octadecanoic acid is an unsaturated fatty acid that is mostly found in oil palm sludge which has 18C atoms and has one double bond, previously none existed in pure cooking oil, but this fatty acid appears in used cooking oil for peanuts, cassava and mackarel tuna., these fatty acids appear due to high frying temperatures and oxygen resulting in the appearance of double bonds.

The used oil produced from frying peanuts, cassava and mackarel tuna was not found with harmful types of fatty acids and there was also no change in cis to trans fatty acids, this was because the frying temperature was not too high so there was no change in cis fatty acids to trans. According to Silalahi and Tampubolong (2020) changes in the configuration of cis to trans fatty acids begin to form at a temperature of 180 ° C and increases with increasing temperature, while the frying temperature used in this study is below 180 ° C.

## CONCLUSION

The results of the characteristics of peanut oil in frying peanuts are peanut aroma, yellow bitter taste, peroxide number 40 meq / kg, free fatty acid content 2.69%, water content 0.17%, yellow test, the amount of oil used in the frying process. 37.8%. The results of the characteristics of the used cassava frying oil are normal aroma, normal taste, yellow color, peroxide number 30 meq / kg, free fatty acid content 3.71%, water content 1.21%, yellow test, the amount of oil used in the frying process 58.4% and the characteristic results of the used tuna frying oil are rancid aroma, black bitter taste, peroxide number 40 meq / kg, free fatty acid content of 4.32%, moisture content 3.21%, brownish yellow color test, the amount of oil used in the frying process is 26.6%,

Changes that occur in the fatty acid profile of the used frying oil for peanuts, cassava and tuna are the change in the percentage of fatty acid types that have increased and decreased in the percentage, the loss of fatty acid types and the emergence of new types of fatty acids from the frying process. This process occurs due to the effect of repeated frying, the effect of the type of fatty acid content of the raw material being fried and the effect of using high heat when frying.

## CONFLICT OF INTEREST

The authors have no conflict of interest.

#### **AUTHOR CONTRIBUTIONS**

Aprialis conducted the experiment, conducted the calculations, Aprialis, Anwar Kasim and Rini wrote and revised the manuscript. All authors agreed to the final version of this manuscript.

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