Title: Identification of Organic Constituents in Cooking Oil by Adding Turmeric as a Potential AntioxidantAgent

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Title of Article: Identification of organic constituents in cooking oil by adding turmeric as a potential antioxidant agent

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Abstract: The objective of this study to compare the fatty acids composition in cooking oil from repeated frying without added turmeric extract and added. The research design is testing the composition of fatty acids in repeated cooking oil using two types of treatment, namely cooking oil from frying without adding turmeric extract and cooking oil from frying with 0.03% turmeric extract added with 10 times frying repeat because it is suspected that repeated frying will increase the composition of fatty acids in cooking oil. The analysis of fatty acids was conducted using gas chromatography. Based on these results that the fatty acid components were produced of saturated fatty acids, namely lauric acid, myristic acid, palmitic acid, and stearic acid, whereas unsaturated fatty acids also detected such as elaidic acid, oleic acid, linoleic acid, cis-11-eicosadienoic acid, linolenic acid, and cis-11,14-eicosadienoic acid. The highest saturated fatty acid content in cooking oil before frying is palmitic acid (30.88%), whereas unsaturated fatty acid was oleic acid (35.86%). The highest content of saturated fatty acids in cooking oil has been added turmeric extract before frying is palmitic acid (28.5%), while unsaturated fatty acid of oleic acid was 32.97%.

Keywords: cooking oil; fatty acid; curcumin; chemical; content

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Identification of organic constituents in cooking oil by adding turmeric as a potential antioxidant agent

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Keywords: cooking oil; fatty acid; curcumin; chemical; content

1. Introduction

Cooking oil is one of the foodstuffs consumed by the majority of Indonesia's population with consumption levels reaching more than 2.5 million tons per year, or more than 12 kg/person/year, and also the dominant foodstuffs used by the community to process of feedstock into food made from palm oil [1]. As a food ingredient, palm oil has several advantages over other cooking oils, which contain carotene as an anti-cancer and tocopherol as a source of vitamin E3. In addition, palm oil can be a non-cholesterol cooking oil (low cholesterol levels) and contains fatty acids which are the main components of fats consisting of saturated and unsaturated fatty acids [2,3]. The main components of saturated fatty acids in palm cooking oil are palmitic acid (C-16), oleic acid (C-18: monounsaturated), and linoleic acid (C-18: polyunsaturated), while the other components are in amounts few are myristic acid (C-14) and stearic acid (C-18) [4]. Palm oil has a fatty acids composition which is different from other cooking oils because it contains a composition of saturated acids that is almost the

same as unsaturated fatty acids, namely 50% saturated fatty acids and 50% unsaturated fatty acids [5].

In the community, cooking oil is widely used in food processing because it can function as a medium for conveying heat, adding a savoury taste, adding nutritional value and calories in food, texture and appearance of food becomes more attractive, and a dry surface [6,7]. In addition, cooking oil can also be used for various food processing processes and is used in almost all types of food preparation such as frying, sautéing, grilling, baking, curling, rolling, and cooking by means of extrusion [8]. Frying is one way to cook raw food into cooked food using cooking oil. Deep frying processing requires a large amount of cooking oil in order to submerge entirely of food ingredients in cooking oil [5]. This condition encourages to use cooking oil repeatedly. The use of cooking oil the longer and more often (repeatedly), the quality will decrease due to oxidation fatty acid. Cooking oil has been oxidized can cause poisoning and other negative effects on human health, but the tendency is that people still often use cooking oil repeatedly for economic purposes [9,10]. In addition to economic factors, it is also due to an increase in prices of basic necessities due to government policies to raise fuel prices, thus encouraging people both industry and households to use cooking oil repeatedly. In developing countries, there are still many repeated frying using cooking oil repeatedly with economic goals. Cooking oil has become an inseparable part of the modern food processing system so that its safety is very important for health institutions throughout the world to provide health insurance among the public in consuming cooking oil [11].

The quality of cooking oil is determined by its constituent fatty acid components, which are classes of saturated or unsaturated fatty acids. Saturated fatty acids have adverse effects on health, otherwise unsaturated fatty acids are a good source of nutrition for health. Saturated fatty acids have the potential to increase blood cholesterol, while unsaturated fatty acids can reduce blood cholesterol. In the cooking process, the chemical composition of cooking oil used has contained frying foodstuffs of unsaturated fatty acids and other byproducts that can reduce the quality of cooking oil so that it becomes toxic and often carcinogenic [12]. The composition of fatty acids in cooking oil changes physicochemical properties due to the thermal process during frying. The physicochemical properties of cooking oil used repeatedly changed at a frying temperature of 180°C and a frying time of 10 minutes by repeating the frying five times, namely the formation of trans fatty acids (chemical properties) and increased viscosity (physical properties) [13]. Some in vivo research results suggest that consumption of thermally oxidized cooking oil may be unhealthy because it can affect the lipid profile, namely an increase in low-density lipoprotein (LDL), a decrease in high-density lipoprotein (HDL) and an increase in cholesterol levels, a haematological system, white blood cell counts. (WBC), neutrophil and lymphocyte counts, obesity, coronary heart disease (CHD) and cardiovascular disease, increased blood pressure, atherosclerosis, kidney function, and can induce lipid peroxidation and oxidative stress that have been linked to the pathogenesis of various degenerative diseases [14,15]. Consumption of coconut oil produces LDL cholesterol which is much higher than non-tropical oil [16].

Based on previous studies, the frying food with a deep frying method using a pan for 15 minutes. The results obtained are that the sample contains more unsaturated fatty acids than saturated, ie palmitic acid is the main saturated fatty acid; oleic acid is the main unsaturated fatty acid with linoleic acid, linolenic acid and palmitoleic acid in varying amounts [8]. Lim et al. has detected the falsification of fresh palm olein (FPO) with RCO using fatty acid compositions and Fourier-transform infrared (FTIR) spectral analysis combined with chemometrics [17]. The FPO is added to the electric frying pan (DFT-6000) with a maximum capacity (5.5 L) and heated for about 20 minutes to reach a temperature of 180°C. The results show a tendency to decrease PUFAs which is consistent with the increasing magnitude of changes in the level of counterfeiting and this might be a good indicator to detect the occurrence of FPO forgery with RCO. Of the two results of this study more specific testing of cooking oil without using additional elements.

Especially, the objective in this study is applied cooking oil with additional elements, namely turmeric extract obtained from the turmeric plant (Curcuma longa) as one of the sources of natural antioxidants that contain curcumin. Turmeric is a useful source of natural antioxidants agent and can provide significant protection against damage to cooking oil due to free radicals and can also prevent fat peroxidation [18,19]. Curcumin ($C_{21}H_{20}O_6$) in turmeric is an active component, hydrophobic yellow-orange polyphenols derived from turmeric rhizomes and has been used in food as a stabilizer in jelly or as a natural dye in cheese and as an additive in traditional medicine [20–22]. According to Abriana and Johannes [23] showed that the addition of turmeric extract into cooking oil can reduce the formation of trans fatty acids and extend the time of use of cooking oil; and based on the results of the analysis of trans fatty acid levels, the best treatment is the addition of turmeric extract at a concentration of 0.03%. The objective to be achieved in this research is to compare the composition of fatty acids in cooking oil from repeated frying without added turmeric extract with cooking oil that has been added turmeric extract. The contribution of this research is more towards food safety and health for consuming fried food.

2. Experimental Methods

This study aims to test the composition of fatty acids in cooking oil from repeated frying using a laboratory experimental test with 2 (two) types of treatment, namely cooking oil from frying without adding turmeric extract and frying oil from frying with added turmeric extract with 10 repetitions of frying because it is suspected that repeated frying will increase the composition of fatty acids in cooking oil. The main focus of research is to uncover the phenomenon of cooking oil due to repeated frying by analyzing fatty acid levels using gas chromatography.

2.1. Preparation of turmeric extract

The use of turmeric extract is a consideration of its function as an antioxidant so that it can inhibit thermal oxidation in cooking oil during frying because it contains curcumin which is a yellow active component and can be extracted from turmeric rhizome. Turmeric is first selected and cleaned, then cut into small pieces or thinly. Then the turmeric is weighed as much as 100 grams for preparation of extraction. 100 grams of turmeric is dried in an oven at 100°C for 1 hour. After drying, then put into a three-neck flask plus 98% glacial acetic acid solvent that has been diluted with a ratio of 1:1 with a total volume of 300 mL solvent. The heater is turned on and the return cooler is activated. The zero time of extraction is determined when glacial acetic acid reaches its boiling point (118.1°C) and ends at the specified time for 75 minutes. The extraction results are cooled and filtered using filter paper. The filtrate is distilled while the residue is removed. The filtrate obtained from the extraction was put into a distillation flask to separate the turmeric extract from the solvent. The heater is turned on and the result is solvent and residue. The residue is dried in an oven at 120°C to remove the residual glacial acetic acid that is still present in turmeric extract. After that weighing is done until a constant weight is obtained. Turmeric extract was added to cooking oil before frying food with a concentration of 0.03% [23].

2.2. Frying of food Test

Food frying is done using the deep frying method by using an electric frying kettle equipped with a temperature and time regulator. The frying process starts by putting fresh cooking oil into the frying boiler as much as 3.5 liters (maximum capacity), then the kettle is heated to a temperature of 180°C. Food is fried until cooked within 10 minutes and made as little as possible stirring to reduce the flow of convection in oil and oxidation reactions due to the aeration process. Analysis was carried out on fresh oil (oil that has not been used for frying foodstuffs) as a control and on two oil samples namely cooking oil from frying without added turmeric extract and cooking oil from frying with added turmeric extract. The oil used for repeating the frying is the same oil (it is not replaced and no additional volume of fresh oil is made). Frying is repeated 10 times with the same temperature and time of frying. Cooking oil samples were taken immediately after the frying process as much as 200 mL, then the oil in the kettle was allowed to cool down and continued with the next frying which is frying first, second, third, fourth, fifth, sixth, seventh, eighth, ninth and tenth [23]. Samples taken for analysis of fatty acid content are samples from the repetition of the first, fifth and tenth frying.

2.3. Characterization of Cooking Oil

First, the cooking oil is hydrolyzed into fatty acids, then transformed into a more volatile ester form. The transformation is carried out by methylation to obtain fatty acid methyl esters (FAME); Furthermore, this FAME was analyzed with GC-2010 (Gas Chromatograph) Plus Serial No. gas chromatography. C11804700336 Shimadzu Corp., using standard methods from The Association of Official Analytical Chemists (AOAC). The analysis starts by injecting of solvent as much as 1.0 µL into the column to obtain a baseline. If the carrier gas flow and heating system are perfect, the peak of the solvent will appear in less than 1 minute. After obtaining the baseline, then proceed by injecting 1 µL of the standard FAME mixture (Supelco TM 37 Component FAME Mix Catalog No. 47885-U, Bellefonte, PA, USA). When all the peaks are out, the prepared sample is injected as much as 1.0 µL. Retention times and peak samples were measured for each component.

3. Results and Discussion

In this study, we produced the component of saturated fatty acids in cooking oil namely lauric acid (C12:0), myristic acid (C14:0), palmitic acid (C16:0), and stearic acid (C18:0) while acids Unsaturated fats such as elaidic acid (C18:1n9t), oleic acid (C18:1n9c), linoleic acid (C18:2n6c), cis-11-eicosenoic acid (C20:1), linolenic acid (C18:3n3), linoleic acid (C18:2n6c), cis-11-eicosenoic acid (C20:1), linolenic acid (C18:3n3), and cis-11,14-eicosadienoic acid (C20:2). The highest saturated fatty acid content in fresh cooking oil (as control) is palmitic acid (C16:0) meanwhile unsaturated fatty acid is oleic acid (C18:1n9c). The higher content of palmitic acid (C16:0) in cooking oil is the major component of palmitic acid in palm oil [11]. The HPLC analysis has exhibited that cooking oil based on palm oil contains the high saturated fatty acid like palmitic acid 30.88% and unsaturated fatty acids namely oleic acid 35.86%, linoleic acid 10.41%, stearic acid 3.43%, mistic acid 0.76%; lauric acid 0.18%; linolenic acid 0.18%; cis-11-eicosenoic acid 0.14%; elaidic acid 0.09% and cis-11,14-eicosadienoic acid 0.07% (Table 1).

Table 1. Composition of fatty Acids from recycled frying cooking oil

Treatment	Fatty Acids	Frying Treatment (time) [%]				Standards based on O'Brien (2003) [24]
		0	1	5	10	
Untreated Cooking Oil	**Saturated Fatty Acids**					
	Lauric Acid, C12:0	0.18 ±0.003	0.18 ±0.010	0.19 ±0.015	0.19 ±0.015	0.1-1.0
	Myristic Acid, C14:0	0.76 ±0.010	0.89 ±0.012	0.86 ±0.036	0.82 ±0.017	0.9-1.5
	Palmitic Acid, C16:0	30.88 ±0.080	34.83 ±0.555	34.00 ±1.167	32.90 ±1.795	41.8-46.8
	Stearic Acid, C18:0	3.43 ±0.035	3.75 ±0.115	3.73 ±0.075	3.68 ±0.367	4.5-5.1
	Unsaturated Fatty Acids					
	Elaidic Acid, C18:1n9t	0.09 ±0.010	0.09 ±0.006	0.11 ±0.001	0.11 ±0.001	<1
	Oleic Acid, C18:1n9c	35.86 ±0.145	40.47 ±0.746	40.18 ±0.812	38.52 ±2.807	37.3-40.8
	Linoleic Acid, C18:2n6c	10.41 ±0.02	11.56 ±0.165	11.41 ±0.214	10.61 ±0.735	9.1-11.0
	Cis-11-Eicosenoic Acid, C20:1	0.14 ±0.006	0.13 ±0.006	0.13 ±0.006	0.13 ±0.015	-
	Linolenic Acid, C18:3n3	0.18 ±0.005	0.20 ±0.010	0.19 ±0.003	0.17 ±0.006	<1.5
	Cis-11,14-Eicosedienoic Acid, C20:2	0.07 ±0.001	0.09 ±0.021	0.10 ±0.017	0.09 ±0.015	-
Cooking Oil + 0.03% Turmeric	**Saturated Fatty Acids**					
	Lauric Acid, C12:0	0.14 ±0.001	0.10 ±0.006	0.11 ±0.006	0.11 ±0.012	0.1-1.0
	Myristic Acid, C14:0	0.77 ±0.010	0.75 ±0.016	0.73 ±0.021	0.81 ±0.051	0.9-1.5
	Palmitic Acid, C16:0	28.5 ±0.580	29.49 ±0.640	29.25 ±0.957	28.75 ±3.788	41.8-46.8
	Stearic Acid, C18:0	2.96 ±0.050	3.44 ±0.081	3.47 ±0.090	3.61 ±0.182	4.5-5.1
	Unsaturated Fatty Acids					
	Elaidic Acid, C18:1n9t	0.07 ±0.001	0.09 ±0.006	0.09 ±0.006	0.09 ±0.006	<1
	Oleic Acid, C18:1n9c	32.97 ±0.560	33.24 ±1.025	34.05 ±1.100	35.43 ±1.974	37.3-40.8
	Linoleic Acid, C18:2n6c	8.89 ±0.160	9.74 ±0.211	9.94 ±0.495	10.19 ±0.560	9.1-11.0
	Cis-11-Eicosenoic Acid, C20:1	0.14 ±0.006	0.11 ±0.006	0.12 ±0.001	0.12 ±0.006	-
	Linolenic Acid, C18:3n3	0.18 ±0.003	0.18 ±0.015	0.18 ±0.017	0.18 ±0.012	<1.5
	Cis-11,14-Eicosedienoic Acid, C20:2	0.06 ±0.001	0.05 ±0.010	0.04 ±0.010	0.06 ±0.010	-

In addition, we added the turmeric extract 0.03% into cooking oil to suppress oxidation reaction shows that the high saturated fatty acid such as palmitic acid 28.5% and unsaturated fatty acids content of oleic acid 32.97%, linoleic acid 8.89%, stearic acid 2.96%, myristic acid 0.77%, linolenic acid 0.18%; lauric acid 0.14%, cis-11-eicosenoic acid 0.14%; elaidic acid 0.07% and cis-11,14-eicosadienoic acid 0.06% (Table 1). The composition of most fatty acids in recycled cooking oil (RCO) is in the range according to Codex standards, except for C8:0, C10:0, C11:0, C11:0, trans C18:1, and polyunsaturated fatty acids (PUFAs), C20:5 [17]. According to Awogbemi [25] reported that palm oil contained 87.7% unsaturated fatty acids and 12.3% saturated fatty acids. Based on these results also show the variation of cooking oil used and type of food fried greatly affect the properties and composition of fatty acids. Overall, in fresh cooking oil was contained 63.16% linoleic acid 20.72%, linolenic acid 10.53%, stearic acid 5.26% and the smallest component was palmitic acid 0.33% [26].

3.1. Saturated Fatty Acids

The saturated fatty acid has been investigated into repeated frying cooking oil based on palm oil, we found the lauric acid, myristic acid, palmitic acid and stearic acid compounds. Certainly, palm oil as feedstock to produce cooking oil contains 92% saturated fatty acids including 48% lauric acid, myristic acid 20%, and palmitic acid 9%, with monounsaturated fatty acids 6% and polyunsaturated fatty acids 1.7% [27]. Figure 1 extracted from Table 1 to observe the range composition and an upward or downward trend in each composition of organic constituents in cooking oil. Figure 1 was recurring frying oil without added turmeric extract showed that before fried the lauric acid of 0.18% (0 times), first frying 0.18% (1 time), fifth frying 0.19% (5 times) and tenth frying 0.19% (10 times). We also compare each organic constituents in cooking oil with results that have been studied from O'brien and Richard D. [24] as standard organic constituents in fats and oils. Based on frying treatment, the lauric acid frequency looks to increase, it means that the repetition of a frying treatment can increase lauric acid compound. Then it is compared with standard 0.1-1.0 shows that not exceed the specified standard.

Meanwhile, the cooking oil has been added turmeric extract 0.03% contains lauric acid of 0.14% (0 times), 0.10% (1 time), 0.11% (5 times) and 0.11% (10 times). The lauric acid frequency was decreased in the first frying, then increase in the fifth and tenth frying (+0.01). By adding 0.03% turmeric extract can reduce the lauric acid compound, then it is compared with a standard data where it does not exceed the predetermined. The lauric acid is also mostly found in virgin coconut oil (VCO) which consists of 90% medium-chain fatty acids (dominated by lauric acid which is 45-55% and 10% long-chain fatty acids). If it is compared with oil palm, VCO has a higher of lauric acid content which is 54.06%, meanwhile in palm oil of 0.10%. Lauric acid plays a role to maintain health, among others, functions to kill various types of microbes derived from fatty acids, to increase metabolic activity, and protect the body from disease and accelerate healing [28]. Among saturated fatty acids, lauric acid has been shown to contribute the least to fat accumulation [29]. Likewise, myristic acid has not exceeded the predetermined standard. Myristic acid (C14:0) is a fatty acid that is found in palm kernel oil and coconut oil which can increase low-density lipoprotein (LDL) cholesterol levels, but it is a minor group in food. It is a long-chain saturated fatty acid (14:0) and also one of the fattiest acids found in milk fat (above 10%) [30].

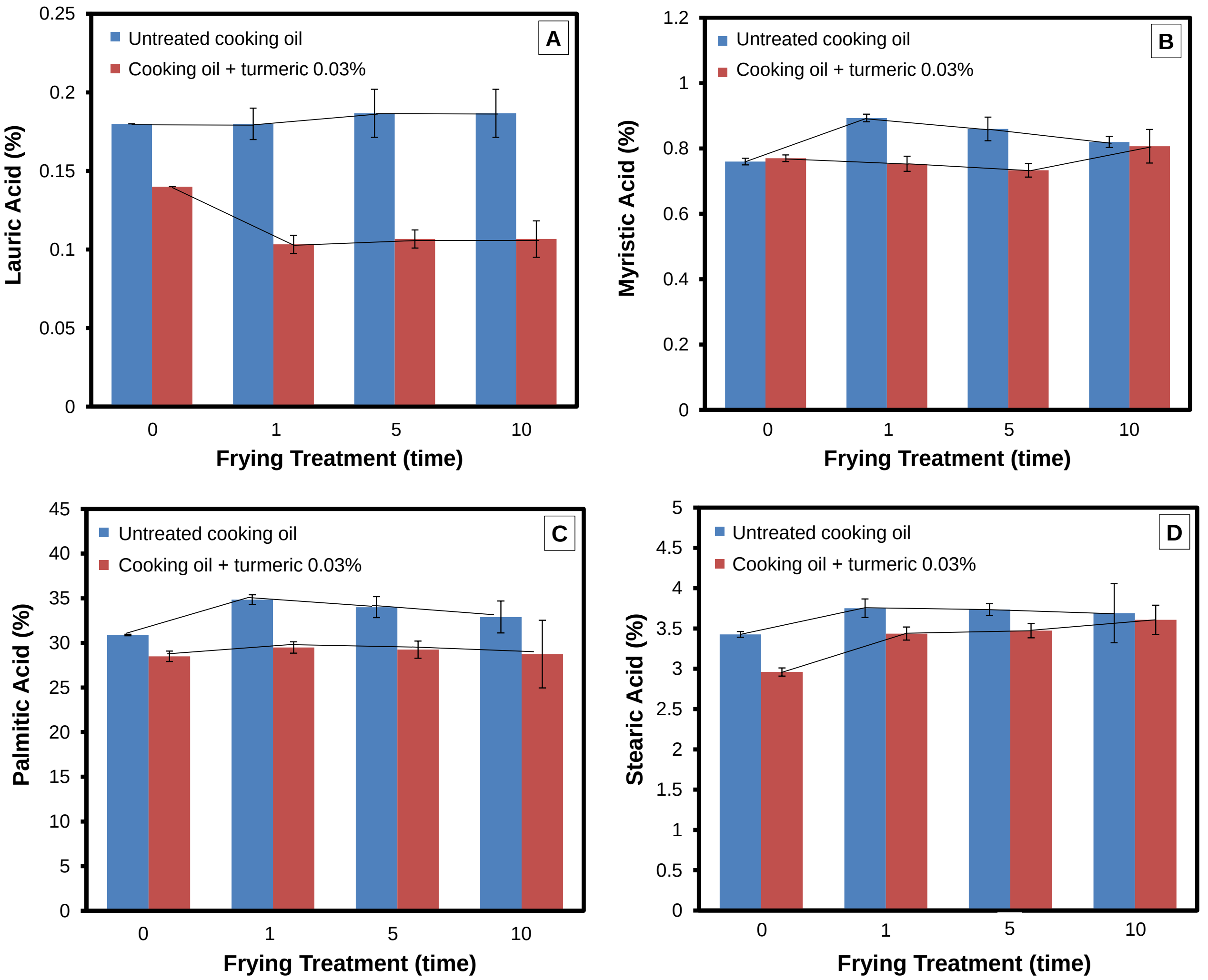

Figure 1. Saturated fatty acids component, (A) Lauric acid, (B) Myristic acid, (C) Palmitic acid and (D) Stearic acid

Figure 1C the palmitic acid was quite increased along with the repetition of the frying and its still lower than the standard which has been specified (41.8-46.8). Palmitic acid is the main fatty acid in palm oil [31]. Palmitic acid is also the main component of saturated fatty acids in food which contains in vegetable oils 6-10% and can increase LDL cholesterol levels. The presence of palmitic acid in cooking oil can be used as an indicator to detect falsification of fresh palm oil (FPO) with RCO using fatty acid composition analysis (FAC) [17]. Figure 1D also exhibited of the stearic acid compound can be seen that has increased along with the repetition of the frying and compared with a standard in a range of 4.5-5.1 where the saturated fatty acid of stearic acid is still lower from predetermined standards. It is a major component of various types of fat with different amounts, such as animal fat (beef fat) containing 15-20% and only a little in vegetable oil, 4-5% [31]. Stearic acid lowers LDL and HDL cholesterol concentrations when compared with palmitic acid because these fatty acids are quickly converted to monounsaturated fatty acids and oleic acid interesterification of fats rich in palmitic acid or stearic acid does not appear to affect serum lipid fasting and (apo) lipoprotein [32].

Based on saturated fatty acid results and compared with standard fats and oils, we discover that the oil from repeated frying produces saturated fatty acids that do not exceed the specified standard. This means that repeated frying oil based on palm oil is still safe for consumption because of all the saturated fatty acids found within the reasonable standard range, though that can raise cholesterol levels (myristic acid and palmitic acid). In vegetable oils such as palm oil is dominated by more carbon atoms, whereas in animal oils are odd carbon atoms and contain more polyunsaturated fatty acids (PUFA) [33]. Cooking oil with high saturated fatty acid content will affect the stability of food items that are fried during frying [34,35]. In addition, the high content of fatty acids causes oil to be easily damaged during cooking processing because the oil will be heated continuously at high temperatures and direct contact with oxygen in the surrounding air which facilitates the oxidation reaction to the oil. According to Baba-Moussa et al. [12] an increase in temperature followed by a long heating time indicates that an increase in the fatty acid component forms triglycerides. The result of triglyceride hydrolysis will produce saturated and unsaturated fatty acids based on the presence or absence of carbon chain double bonds in the molecule.

3.2. Unsaturated Fatty Acids

The presence of organic constituents in repeated frying oil have been examined that it is containing elaidic acid, oleic acid, linoleic acid, cis-11-eicosenoic acid, linolenic acid, and cis-11,14-eicosadienoic acid. Based on Figure 2A the content of untreated cooking oil from elaidic acid showed that 0.09% (0 times), 0.09% (1 time), 0.11% (5 times) and 0.11% (10 times), while the frying oil added 0.03% turmeric extract showed the treatment before frying 0.07% (0 times), 0.09% (1 time), 0.09% (5 times) and 0.09% (10 times). If seen from the frequency of elaidic acid (Figure 2A) that repeated frying can increase the level of elaidic acid and compare with standard <1 that it does not exceed the specified standard. This is because trans fatty acids (TFA) in elaidic acid are unsaturated fatty acid with at least one double bond in the form of trans configuration that can occur naturally from ruminants-based meat and dairy products, or artificially through partial hydrogenation of vegetable oils in industry food processing [36]. Sartika also reported that trans fatty acids (elaidate) were only formed after the second repetition of deep-frying, and their levels increased with the repeated use of oil. Based on the initial formation of trans fatty acids, the frying process should be done on medium heat (<200°C) and the cooking oil used should not exceed 2 (two) repetitions. Not so in the oleic acid compound (Figure 2B) shows a tendency to vary, if it is compared with the standard of 37.3-40.8. Whereas the recycled frying oil added with 0.03% turmeric extract showed an increase along with the repetition of the frying and when compared with the standard 37.3-40.8. These results indicate that oleic acid is still lower than the standard value.

Furthermore, the content of linoleic acid (Figure 2C) in untreated cooking oil showed the same conditions varying when compared with the standard of 9.1-11.0. One that met the standard was the treatment before the tenth frying and frying, while those that do not meet the standards in the first and fifth frying treatment. Then, it compared with frying cooking oil added 0.03% turmeric extract showed an increase along with the repetition of the frying and compared with the standard the first, fifth and tenth frying have met the standards. Meanwhile which did not meet the standards in the treatment before the addition of turmeric extract such as the first and fifth frying. From this result showed that repeated frying can increase the levels of linoleic acid in the oil from repeated frying by adding 0.03% turmeric extract. It is due to the conjugation of linolenic acid isomer refers to a group of positions and geometrical isomers of omega-3-α-linolenic acid essential acids (cis-9, cis-12, cis-15 C18: 3; ALA) [37,38].

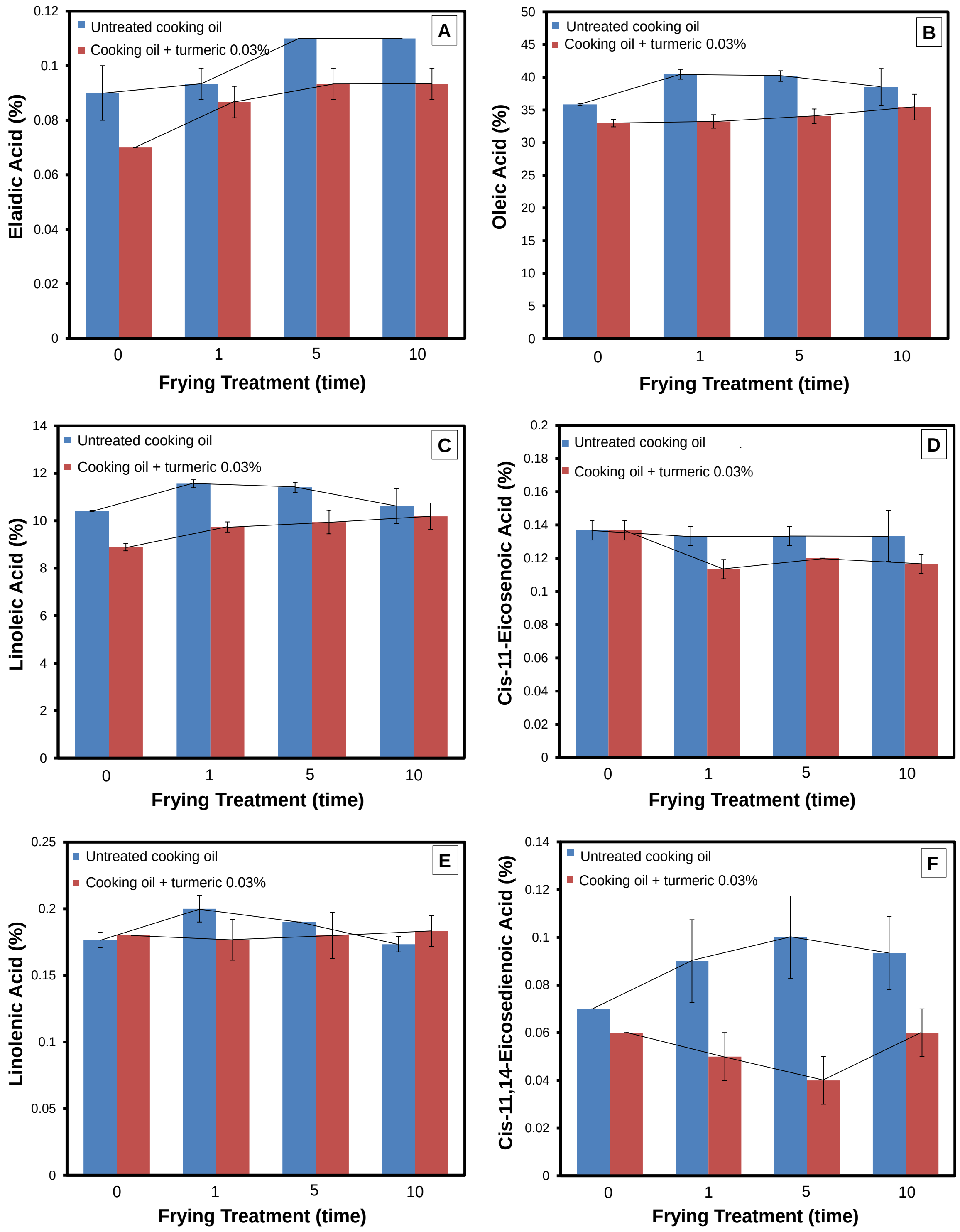

Figure 2. Unsaturated fatty acids component (A) elaidic acid, (B) oleic acid, (C) linoleic acid, (D) cis-11-eicosenoic acid, (E) linolenic acid, and (F) cis-11,14-eicosadienoic acid

The content of cis-11-eicosenoic acid (Figure 2D) in untreated cooking oil and added 0.03% turmeric extract has decreased levels caused by slow oxidation reactions against cis-11-eicosenoic acid. The frequency of linolenic acid (Figure 2E) in unprocessed cooking oil shows a variable trend. At the beginning of the frying (1 time), there was an increase compared to those not treated, but over time the frying duration decreases. In otherwise, by adding turmeric extract shows a quite static level before frying to the tenth repetition treatment. It shows the turmeric extract can suppress the occurrence oxidation reaction. Meanwhile, Figure 2F depicts cis-11-14-eicosadienoic acid has increased in untreated cooking oil, while the unique by adding turmeric extract dramatically decrease levels. It is concluded cooking oil without treatment has shown increase unsaturated acid levels. The performance of turmeric extract has quite demonstrated efficiency to suppress chemical reaction during frying treatment [39]. In addition, turmeric extract can function as an antioxidant so that it can inhibit thermal oxidation in cooking oil during repeated frying. This will affect the composition of fatty acids contained in cooking oil. According to Kim and Clifton [40] showed that curcumin (diferuloylmethane) is the main secondary metabolite in turmeric extract which is beneficial to the human body as antioxidant and anti-inflammatory properties. Curcumin as a bioactive component has been shown to be a broad biological action. To date, it has been reported that natural coloured extracts are isolated from turmeric by various methods such as maceration, digestion, microwave and infusion [21]. Turmeric varieties studied by Tanvir et al. [18] is a useful source of natural antioxidants and can provide protection against free radical damage. Curcumin can be used as a food additive and is also good for use as conventional medicine [41].

4. Conclusions

This study reports the chemical composition of cooking oil consisting of saturated fatty acids, such as lauric acid, myristic acid, palmitic acid, and stearic acid. Whereas, the unsaturated fatty acids of elaidic acid, oleic acid, linoleic acid, cis-11-eicosedienoic acid, linolenic acid, and cis-11,14-eicosedienoic acid. The highest saturated fatty acid levels in cooking oil before frying are palmitic acid of 30.88%, whereas unsaturated fatty acids, namely oleic acid of 35.86%. The highest saturated fatty acid content in the oil which has added turmeric extract before frying is palmitic acid of 28.5%, while unsaturated fatty acids like oleic acid of 32.97%. Turmeric extract added to cooking oil can function as an anticosidan so that it can inhibit thermal oxidation in cooking oil during repeated frying. The treatment of repeated frying affects the fatty acids contained in repeated cooking oils, both saturated fatty acids and unsaturated fatty acids.

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Conflicts of Interest

We declare that this article has no conflict of interest

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Identification of Organic Constituents in Cooking Oil by Adding Turmeric as a Potential Antioxidant Agent

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Abstract: The objective of this study to compare the fatty acids composition in cooking oil from repeated frying without added turmeric extract and added. The research design is testing the composition of fatty acids in repeated cooking oil using two types of treatment, namely cooking oil from frying without adding turmeric extract and cooking oil from frying with 0.03% turmeric extract added with 10 times frying repeat because it is suspected that repeated frying will increase the composition of fatty acids in cooking oil. The analysis of fatty acids was conducted using gas chromatography. Based on these results that the fatty acid components were produced of saturated fatty acids, namely lauric acid, myristic acid, palmitic acid, and stearic acid, whereas unsaturated fatty acids also detected such as elaidic acid, oleic acid, linoleic acid, cis-11-eicosadienoic acid, linolenic acid, and cis-11,14-eicosadienoic acid. The highest saturated fatty acid content in cooking oil before frying is palmitic acid (30.88%), whereas unsaturated fatty acid was oleic acid (35.86%). The highest content of saturated fatty acids in cooking oil has been added turmeric extract before frying is palmitic acid (28.5%), while unsaturated fatty acid of oleic acid was 32.97%.

Keywords: cooking oil; fatty acid; curcumin; chemical; content.

1. Introduction

Cooking oil is one of the foodstuffs consumed by the majority of Indonesia's population with consumption levels reaching more than 2.5 million tons per year, or more than 12 kg/person/year, and also the dominant foodstuffs used by the community to process of feedstock into food made from palm oil [1]. As a food ingredient, palm oil has several advantages over other cooking oils, which contain carotene as an anti-cancer and tocopherol as a source of vitamin E3. In addition, palm oil can be a non-cholesterol cooking oil (low cholesterol levels) and contains fatty acids, which are the main components of fats consisting of saturated and unsaturated fatty acids [2,3]. The main components of saturated fatty acids in palm cooking oil are palmitic acid (C-16), oleic acid (C-18: monounsaturated), and linoleic acid (C-18: polyunsaturated), while the other components are in amounts, few are myristic acid (C-14) and stearic acid (C-18) [4]. Palm oil has a fatty acids composition, which is different from other cooking oils because it contains a composition of saturated acids that is almost the

same as unsaturated fatty acids, namely 50% saturated fatty acids and 50% unsaturated fatty acids [5].

In the community, cooking oil is widely used in food processing because it can function as a medium for conveying heat, adding a savoury taste, adding nutritional value and calories in food, texture, and appearance of food becomes more attractive, and a dry surface [6,7]. In addition, cooking oil can also be used for various food processing processes and is used in almost all types of food preparation such as frying, sautéing, grilling, baking, curling, rolling, and cooking by means of extrusion [8]. Frying is one way to cook raw food into cooked food using cooking oil. Deep frying processing requires a large amount of cooking oil in order to submerge entirely of food ingredients in cooking oil [5]. This condition encourages to use cooking oil repeatedly. The use of cooking oil the longer and more often (repeatedly), the quality will decrease due to oxidation fatty acid. Cooking oil has been oxidized can cause poisoning and other negative effects on human health, but the tendency is that people still often use cooking oil repeatedly for economic purposes [9,10]. In addition to economic factors, it is also due to an increase in prices of basic necessities due to government policies to raise fuel prices, thus encouraging people both industry and households to use cooking oil repeatedly. In developing countries, there are still many repeated frying using cooking oil repeatedly with economic goals. Cooking oil has become an inseparable part of the modern food processing system so that its safety is very important for health institutions throughout the world to provide health insurance among the public in consuming cooking oil [11].

The quality of cooking oil is determined by its constituent fatty acid components, which are classes of saturated or unsaturated fatty acids. Saturated fatty acids have adverse effects on health, ; otherwise unsaturated fatty acids are a good source of nutrition for health. Saturated fatty acids have the potential to increase blood cholesterol, while unsaturated fatty acids can reduce blood cholesterol. In the cooking process, the chemical composition of cooking oil used has contained frying foodstuffs of unsaturated fatty acids and other byproducts that can reduce the quality of cooking oil so that it becomes toxic and often carcinogenic [12]. The composition of fatty acids in cooking oil changes physicochemical properties due to the thermal process during frying. The physicochemical properties of cooking oil used repeatedly changed at a frying temperature of 180°C and a frying time of 10 minutes by repeating the frying five times, namely the formation of trans fatty acids (chemical properties) and increased viscosity (physical properties) [13]. Some in vivo research results suggest that consumption of thermally oxidized cooking oil may be unhealthy because it can affect the lipid profile, namely an increase in low-density lipoprotein (LDL), a decrease in high-density lipoprotein (HDL) and an increase in cholesterol levels, a haematological system, white blood cell counts. (WBC), neutrophil and lymphocyte counts, obesity, coronary heart disease (CHD) and cardiovascular disease, increased blood pressure, atherosclerosis, kidney function, and can induce lipid peroxidation and oxidative stress that have been linked to the pathogenesis of various degenerative diseases [14,15]. Consumption of coconut oil produces LDL cholesterol, which is much higher than non-tropical oil [16].

Based on previous studies, the frying food with a deep frying method using a pan for 15 minutes. The results obtained are that the sample contains more unsaturated fatty acids than saturated, ie, palmitic acid is the main saturated fatty acid; oleic acid is the main unsaturated fatty acid with linoleic acid, linolenic acid, and palmitoleic acid in varying amounts [8]. Lim et al. has detected the falsification of fresh palm olein (FPO) with RCO using fatty acid compositions and Fourier-transform infrared (FTIR) spectral analysis combined with

chemometrics [17]. The FPO is added to the electric frying pan (DFT-6000) with a maximum capacity (5.5 L) and heated for about 20 minutes to reach a temperature of 180°C. The results show a tendency to decrease PUFAs, which is consistent with the increasing magnitude of changes in the level of counterfeiting, and this might be a good indicator to detect the occurrence of FPO forgery with RCO. Of the two results of this study, more specific testing of cooking oil without using additional elements.

Especially, the objective in this study is applied cooking oil with additional elements, namely turmeric extract obtained from the turmeric plant (Curcuma longa) as one of the sources of natural antioxidants that contain curcumin. Turmeric is a useful source of natural antioxidants agents and can provide significant protection against damage to cooking oil due to free radicals and can also prevent fat peroxidation [18,19]. Curcumin ($C_{21}H_{20}O_6$) in turmeric is an active component, hydrophobic yellow-orange polyphenols derived from turmeric rhizomes, and has been used in food as a stabilizer in jelly or as a natural dye in cheese and as an additive in traditional medicine [20–22]. According to Abriana and Johannes [23] showed that the addition of turmeric extract into cooking oil ~~can~~ could reduce the formation of trans fatty acids and extend the time of use of cooking oil; and based on the results of the analysis of trans fatty acid levels, the best treatment is the addition of turmeric extract at a concentration of 0.03%. The objective to be achieved in this research is to compare the composition of fatty acids in cooking oil from repeated frying without added turmeric extract with cooking oil that has been added turmeric extract. The contribution of this research is more towards food safety and health for consuming fried food.

2. Materials and Methods

This study aims to test the composition of fatty acids in cooking oil from repeated frying using a ~~laboratory experimental~~n experimental laboratory test with 2 (two) types of treatment, namely cooking oil from frying without adding turmeric extract and frying oil from frying with added turmeric extract with 10 repetitions of frying because it is suspected that repeated frying will increase the composition of fatty acids in cooking oil. The main focus of research is to uncover the phenomenon of cooking oil due to repeated frying by analyzing fatty acid levels using gas chromatography.

2.1. Preparation of turmeric extract.

The use of turmeric extract is a consideration of its function as an antioxidant so that it can inhibit thermal oxidation in cooking oil during frying because it contains curcumin, which is a yellow active component and can be extracted from turmeric rhizome. Turmeric is first selected and cleaned, then cut into small pieces or thinly. Then the turmeric is weighed as much as 100 grams for preparation of extraction. 100 grams of turmeric is dried in an oven at 100°C for 1 hour. After drying, then put into a three-neck flask plus 98% glacial acetic acid solvent that has been diluted with a ratio of 1:1 with a total volume of 300 mL solvent. The heater is turned on, and the return cooler is activated. The zero time of extraction is determined when glacial acetic acid reaches its boiling point (118.1°C) and ends at the specified time for 75 minutes. The extraction results are cooled and filtered using filter paper. The filtrate is distilled while the residue is removed. The filtrate obtained from the extraction was put into a distillation flask to separate the turmeric extract from the solvent. The heater is turned on, and the result is solvent and residue. The residue is dried in an oven at 120°C to remove the residual glacial acetic acid

that is still present in turmeric extract. After that, weighing is done until a constant weight is obtained. Turmeric extract was added to cooking oil before frying food with a concentration of 0.03% [23].

2.2. Frying of food Test.

Food frying is done using the deep frying method by using an electric frying kettle equipped with a temperature and time regulator. The frying process starts by putting fresh cooking oil into the frying boiler as much as 3.5 liters (maximum capacity), then the kettle is heated to a temperature of 180°C. Food is fried until cooked within 10 minutes and made as little as possible stirring to reduce the flow of convection in oil and oxidation reactions due to the aeration process. ~~Analysis~~ The analysis was carried out on fresh oil (oil that has not been used for frying foodstuffs) as ~~a~~ control and on two oil samples, namely cooking oil from frying without added turmeric extract and cooking oil from frying with added turmeric extract. The oil used for repeating the frying is the same oil (it is not replaced, and no additional volume of fresh oil is made). Frying is repeated 10 times with the same temperature and time of frying. Cooking oil samples were taken immediately after the frying process as much as 200 mL, then the oil in the kettle was allowed to cool down and continued with the next frying which is frying first, second, third, fourth, fifth, sixth, seventh, eighth, ninth and tenth [23]. Samples taken for analysis of fatty acid content are samples from the repetition of the first, fifth, and tenth frying.

2.3. Characterization of Cooking Oil.

First, the cooking oil is hydrolyzed into fatty acids, then transformed into a more volatile ester form. The transformation is carried out by methylation to obtain fatty acid methyl esters (FAME); Furthermore, this FAME was analyzed with GC-2010 (Gas Chromatograph) Plus Serial No. gas chromatography. C11804700336 Shimadzu Corp., using standard methods from The Association of Official Analytical Chemists (AOAC). The analysis starts by injecting of solvent as much as 1.0 µL into the column to obtain a baseline. If the carrier gas flow and heating system are perfect, the peak of the solvent will appear in less than 1 minute. After obtaining the baseline, then proceed by injecting 1 µL of the standard FAME mixture (Supelco TM 37 Component FAME Mix Catalog No. 47885-U, Bellefonte, PA, USA). When all the peaks are out, the prepared sample is injected as much as 1.0 µL. Retention times and peak samples were measured for each component.

3. Results and Discussion

In this study, we produced the component of saturated fatty acids in cooking oil namely lauric acid (C12:0), myristic acid (C14:0), palmitic acid (C16:0), and stearic acid (C18:0) while acids Unsaturated fats such as elaidic acid (C18:1n9t), oleic acid (C18:1n9c), linoleic acid (C18:2n6c), cis-11-eicosenoic acid (C20:1), linolenic acid (C18:3n3), linoleic acid (C18:2n6c), cis-11-eicosenoic acid (C20:1), linolenic acid (C18:3n3), and cis-11,14-eicosadienoic acid (C20:2). The highest saturated fatty acid content in fresh cooking oil (as control) is palmitic acid (C16:0) meanwhile, unsaturated fatty acid is oleic acid (C18:1n9c). The higher content of palmitic acid (C16:0) in cooking oil is the major component of palmitic acid in palm oil [11]. The HPLC analysis has exhibited that cooking oil based on palm oil contains the high saturated fatty acid like palmitic acid 30.88% and unsaturated fatty acids namely oleic acid 35.86%, linoleic acid 10.41%, stearic acid 3.43%, mistic acid 0.76%; lauric acid 0.18%; linolenic acid 0.18%; cis-11-eicosenoic acid 0.14%; elaidic acid 0.09% and cis-11,14-eicosadienoic acid 0.07% (Table 1).

Table 1. Composition of fatty Acids from recycled frying cooking oil.

Treatment	Fatty Acids	Frying Treatment (time) [%]				Standards based on O'Brien (2003) [24]
		0	1	5	10	
Untreated Cooking Oil	**Saturated Fatty Acids**					
	Lauric Acid, C12:0	0.18 ±0.003	0.18 ±0.010	0.19 ±0.015	0.19 ±0.015	0.1-1.0
	Myristic Acid, C14:0	0.76 ±0.010	0.89 ±0.012	0.86 ±0.036	0.82 ±0.017	0.9-1.5
	Palmitic Acid, C16:0	30.88 ±0.080	34.83 ±0.555	34.00 ±1.167	32.90 ±1.795	41.8-46.8
	Stearic Acid, C18:0	3.43 ±0.035	3.75 ±0.115	3.73 ±0.075	3.68 ±0.367	4.5-5.1
	Unsaturated Fatty Acids					
	Elaidic Acid, C18:1n9t	0.09 ±0.010	0.09 ±0.006	0.11 ±0.001	0.11 ±0.001	<1
	Oleic Acid, C18:1n9c	35.86 ±0.145	40.47 ±0.746	40.18 ±0.812	38.52 ±2.807	37.3-40.8
	Linoleic Acid, C18:2n6c	10.41 ±0.02	11.56 ±0.165	11.41 ±0.214	10.61 ±0.735	9.1-11.0
	Cis-11-Eicosenoic Acid, C20:1	0.14 ±0.006	0.13 ±0.006	0.13 ±0.006	0.13 ±0.015	-
	Linolenic Acid, C18:3n3	0.18 ±0.005	0.20 ±0.010	0.19 ±0.003	0.17 ±0.006	<1.5
	Cis-11,14-Eicosedienoic Acid, C20:2	0.07 ±0.001	0.09 ±0.021	0.10 ±0.017	0.09 ±0.015	-
Cooking Oil + 0.03% Turmeric	**Saturated Fatty Acids**					
	Lauric Acid, C12:0	0.14 ±0.001	0.10 ±0.006	0.11 ±0.006	0.11 ±0.012	0.1-1.0
	Myristic Acid, C14:0	0.77 ±0.010	0.75 ±0.016	0.73 ±0.021	0.81 ±0.051	0.9-1.5
	Palmitic Acid, C16:0	28.5 ±0.580	29.49 ±0.640	29.25 ±0.957	28.75 ±3.788	41.8-46.8
	Stearic Acid, C18:0	2.96 ±0.050	3.44 ±0.081	3.47 ±0.090	3.61 ±0.182	4.5-5.1
	Unsaturated Fatty Acids					
	Elaidic Acid, C18:1n9t	0.07 ±0.001	0.09 ±0.006	0.09 ±0.006	0.09 ±0.006	<1
	Oleic Acid, C18:1n9c	32.97 ±0.560	33.24 ±1.025	34.05 ±1.100	35.43 ±1.974	37.3-40.8
	Linoleic Acid, C18:2n6c	8.89 ±0.160	9.74 ±0.211	9.94 ±0.495	10.19 ±0.560	9.1-11.0
	Cis-11-Eicosenoic Acid, C20:1	0.14 ±0.006	0.11 ±0.006	0.12 ±0.001	0.12 ±0.006	-
	Linolenic Acid, C18:3n3	0.18 ±0.003	0.18 ±0.015	0.18 ±0.017	0.18 ±0.012	<1.5
	Cis-11,14-Eicosedienoic Acid, C20:2	0.06 ±0.001	0.05 ±0.010	0.04 ±0.010	0.06 ±0.010	-

In addition, we added the turmeric extract 0.03% into cooking oil to suppress oxidation reaction shows that the high saturated fatty acid such as palmitic acid 28.5% and unsaturated fatty acids content of oleic acid 32.97%, linoleic acid 8.89%, stearic acid 2.96%, myristic acid 0.77%, linolenic acid 0.18%; lauric acid 0.14%, cis-11-eicosenoic acid 0.14%; elaidic acid 0.07% and cis-11,14-eicosadienoic acid 0.06% (Table 1). The composition of most fatty acids in recycled cooking oil (RCO) is in the range according to Codex standards, except for C8:0, C10:0, C11:0, C11:0, trans C18:1, and polyunsaturated fatty acids (PUFAs), C20:5 [17]. According to Awogbemi [25] reported that palm oil contained 87.7% unsaturated fatty acids and 12.3% saturated fatty acids. Based on these results also show the variation of cooking oil used and type of food fried greatly affect the properties and composition of fatty acids. Overall, in fresh cooking oil was contained 63.16% linoleic acid 20.72%, linolenic acid 10.53%, stearic acid 5.26%, and the smallest component was palmitic acid 0.33% [26].

3.1. Saturated fatty acids.

The saturated fatty acid has been investigated into repeated frying cooking oil based on palm oil,; we found the lauric acid, myristic acid, palmitic acid, and stearic acid compounds. Certainly, palm oil as feedstock to produce cooking oil contains 92% saturated fatty acids, including 48% lauric acid, myristic acid 20%, and palmitic acid 9%, with monounsaturated fatty acids 6% and polyunsaturated fatty acids 1.7% [27]. Figure 1 extracted from Table 1 to observe the range composition and an upward or downward trend in each composition of organic constituents in cooking oil. Figure 1 was recurring frying oil without added turmeric extract showed that before fried the lauric acid of 0.18% (0 times), first frying 0.18% (1 time), fifth frying 0.19% (5 times) and tenth frying 0.19% (10 times). We also compare each organic constituents in cooking oil with results that have been studied from O'brien O'Brien and Richard D. [24] as standard organic constituents in fats and oils. Based on frying treatment, the lauric acid frequency looks to increase, ; it means that the repetition of a frying treatment can increase the lauric acid compound. Then it is compared with standard 0.1-1.0 shows that do not exceed the specified standard.

Meanwhile, the cooking oil has been added turmeric extract 0.03% contains lauric acid of 0.14% (0 times), 0.10% (1 time), 0.11% (5 times) and 0.11% (10 times). The lauric acid frequency was decreased in the first frying, then increase in the fifth and tenth frying (+0.01). By adding 0.03% turmeric extract can reduce the lauric acid compound, then it is compared with a standard data where it does not exceed the predetermined. The lauric acid is also mostly found in virgin coconut oil (VCO), which consists of 90% medium-chain fatty acids (dominated by lauric acid, which is 45-55% and 10% long-chain fatty acids). If it is compared with oil palm, VCO has a higher of lauric acid content, which is 54.06%, meanwhile in palm oil of 0.10%. Lauric acid plays a role to maintainin maintaining health, among others, functions to kill various types of microbes derived from fatty acids, to increase metabolic activity, and protect the body from disease and accelerate healing [28]. Among saturated fatty acids, lauric acid has been shown to contribute the least to fat accumulation [29]. Likewise, myristic acid has not exceeded the predetermined standard. Myristic acid (C14:0) is a fatty acid that is found in palm kernel oil and coconut oil, which can increase low-density lipoprotein (LDL) cholesterol levels, but it is a minor group in food. It is a long-chain saturated fatty acid (14:0) and also one of the fattiest acids found in milk fat (above 10%) [30].

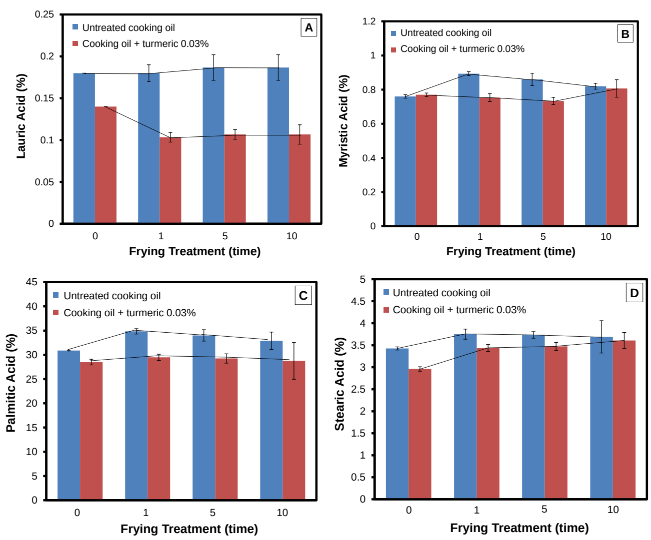

Figure 1. Saturated fatty acids component, (A) Lauric acid, (B) Myristic acid, (C) Palmitic acid and (D) Stearic acid.

Figure 1C the palmitic acid was quite increased along with the repetition of the frying, and it's still lower than the standard which has been specified (41.8-46.8). Palmitic acid is the main fatty acid in palm oil [31]. Palmitic acid is also the main component of saturated fatty acids in food, which contains in vegetable oils 6-10% and can increase LDL cholesterol levels. The presence of palmitic acid in cooking oil can be used as an indicator to detect falsification of fresh palm oil (FPO) with RCO using fatty acid composition analysis (FAC) [17]. Figure 1D also exhibited of the stearic acid compound can be seen that has increased along with the repetition of the frying and compared with a standard in a range of 4.5-5.1 where the saturated fatty acid of stearic acid is still lower from predetermined standards. It is a major component of various types of fat with different amounts, such as animal fat (beef fat) containing 15-20% and only a little in vegetable oil, 4-5% [31]. Stearic acid lowers LDL and HDL cholesterol concentrations when compared with palmitic acid because these fatty acids are quickly converted to monounsaturated fatty acids and oleic acid interesterification of fats rich in palmitic acid or stearic acid does not appear to affect serum lipid fasting and (apo) lipoprotein [32].

Based on saturated fatty acid results and compared with standard fats and oils, we discover that the oil from repeated frying produces saturated fatty acids that do not exceed the specified standard. This means that repeated frying oil based on palm oil is still safe for consumption because of all the saturated fatty acids found within the reasonable standard range, though that can raise cholesterol levels (myristic acid and palmitic acid). In vegetable oils such as palm oil is dominated by more carbon atoms, whereas in animal oils are odd carbon atoms and contain more polyunsaturated fatty acids (PUFA) [33]. Cooking oil with high saturated fatty acid content will affect the stability of food items that are fried during frying [34,35]. In addition, the high content of fatty acids causes oil to be easily damaged during cooking processing because the oil will be heated continuously at high temperatures and direct contact with oxygen in the surrounding air, which facilitates the oxidation reaction to the oil. According to Baba-Moussa et al. [12], an increase in temperature followed by a long heating time indicates that an increase in the fatty acid component forms triglycerides. The result of triglyceride hydrolysis will produce saturated and unsaturated fatty acids based on the presence or absence of carbon chain double bonds in the molecule.

3.2. Unsaturated fatty acids.

The presence of organic constituents in repeated frying oil have has been examined that it is containingcontains elaidic acid, oleic acid, linoleic acid, cis-11-eicosenoic acid, linolenic acid, and cis-11,14-eicosadienoic acid. Based on Figure 2A the content of untreated cooking oil from elaidic acid showed that 0.09% (0 times), 0.09% (1 time), 0.11% (5 times) and 0.11% (10 times), while the frying oil added 0.03% turmeric extract showed the treatment before frying 0.07% (0 times), 0.09% (1 time), 0.09% (5 times) and 0.09% (10 times). If seen from the frequency of elaidic acid (Figure 2A) that repeated frying can increase the level of elaidic acid and compare with standard <1 that it does not exceed the specified standard. This is because trans fatty acids (TFA) in elaidic acid are unsaturated fatty acids with at least one double bond in the form of trans configuration that can occur naturally from ruminants-based meat and dairy products, or artificially through partial hydrogenation of vegetable oils in industry food processing [36]. Sartika also reported that trans fatty acids (elaidate) were only formed after the second repetition of deep-frying, and their levels increased with the repeated use of oil. Based on the initial formation of trans fatty acids, the frying process should be done on medium heat (<200°C), and the cooking oil used should not exceed 2 (two) repetitions. Not so in the oleic acid compound (Figure 2B) shows a tendency to vary, if it is compared with the standard of 37.3-40.8. Whereas the recycled frying oil added with 0.03% turmeric extract showed an increase along with the repetition of the frying and when compared with the standard 37.3-40.8. These results indicate that oleic acid is still lower than the standard value.

Furthermore, the content of linoleic acid (Figure 2C) in untreated cooking oil showed the same conditions varying when compared with the standard of 9.1-11.0. One that met the standard was the treatment before the tenth frying and frying, while those that do not meet the standards in the first and fifth frying treatment. Then, it compared with frying cooking oil added 0.03% turmeric extract showed an increase along with the repetition of the frying and compared with the standard the first, fifth, and tenth frying have met the standards. Meanwhile, which did not meet the standards in the treatment before the addition of turmeric extract such as the first and fifth frying. ~~From t~~This result showed that repeated frying ~~can~~ could increase the levels of linoleic acid in the oil from repeated frying by adding 0.03% turmeric extract. It is due to the conjugation of linolenic acid isomer refers to a group of positions and geometrical isomers of omega-3-α-linolenic acid essential acids (cis-9, cis-12, cis-15 C18: 3; ALA) [37,38].

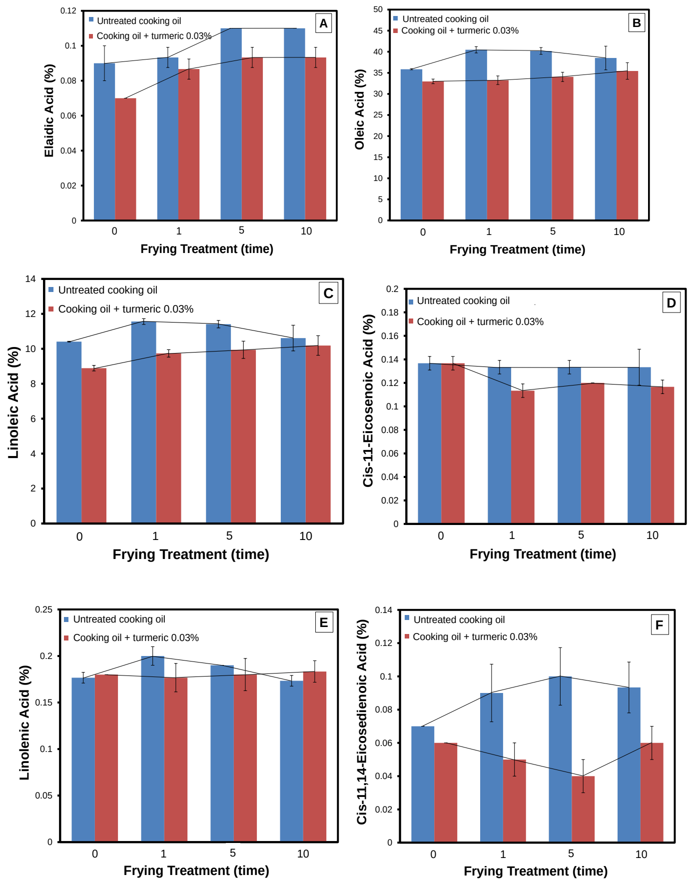

Figure 2. Unsaturated fatty acids component (A) elaidic acid, (B) oleic acid, (C) linoleic acid, (D) cis-11-eicosenoic acid, (E) linolenic acid, and (F) cis-11,14-eicosadienoic acid.

The content of cis-11-eicosenoic acid (Figure 2D) in untreated cooking oil and added 0.03% turmeric extract ~~has~~ had decreased levels caused by slow oxidation reactions against cis-11-eicosenoic acid. The frequency of linolenic acid (Figure 2E) in unprocessed cooking oil shows a variable trend. At the beginning of the frying (1 time), there was an increase compared to those not treated, but over time the frying duration decreases. In otherwise, by adding turmeric extract shows a quite static level before frying to the tenth repetition treatment. It shows ~~the~~ that turmeric extract can suppress the occurrence oxidation reaction. Meanwhile, Figure 2F depicts cis-11-14-eicosadienoic acid has increased in untreated cooking oil, while the unique by adding turmeric extract dramatically decrease levels. It is concluded cooking oil without treatment has shown increase unsaturated acid levels. The performance of turmeric extract has quite demonstrated efficiency ~~to suppress~~in suppressing chemical reactions during frying treatment [39]. In addition, turmeric extract can function as an antioxidant so that it can inhibit thermal oxidation in cooking oil during repeated frying. This will affect the composition of fatty acids contained in cooking oil. According to Kim and Clifton [40] showed that curcumin (diferuloylmethane) is the main secondary metabolite in turmeric extract, which is beneficial to the human body as antioxidant and anti-inflammatory properties. Curcumin, as a bioactive component, has been shown to be a broad biological action. To date, it has been reported that natural colo~~u~~red extracts are isolated from turmeric by various methods such as maceration, digestion, microwave, and infusion [21]. Turmeric varieties studied by Tanvir et al. [18] is a useful source of natural antioxidants and can provide protection against free radical damage. Curcumin can be used as a food additive and is also good for use as conventional medicine [41].

4. Conclusions

This study reports the chemical composition of cooking oil consisting of saturated fatty acids, such as lauric acid, myristic acid, palmitic acid, and stearic acid. Whereas, the unsaturated fatty acids of elaidic acid, oleic acid, linoleic acid, cis-11-eicosedienoic acid, linolenic acid, and cis-11,14-eicosedienoic acid. The highest saturated fatty acid levels in cooking oil before frying, are palmitic acid of 30.88%, whereas unsaturated fatty acids, namely oleic acid of 35.86%. The highest saturated fatty acid content in the oil which has added turmeric extract before frying is palmitic acid of 28.5%, while unsaturated fatty acids like oleic acid of 32.97%. Turmeric extract added to cooking oil can function as an anticosidan so that it can inhibit thermal oxidation in cooking oil during repeated frying. The treatment of repeated frying affects the fatty acids contained in repeated cooking oils, both saturated fatty acids and unsaturated fatty acids.

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Conflicts of Interest

The authors declare no conflict of interest.

References

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Identification of Organic Constituents in Cooking Oil by Adding Turmeric as a Potential Antioxidant Agent

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Abstract: The objective of this study to compare the fatty acids composition in cooking oil from repeated frying without added turmeric extract and added. The research design is testing the composition of fatty acids in repeated cooking oil using two types of treatment, namely cooking oil from frying without adding turmeric extract and cooking oil from frying with 0.03% turmeric extract added with 10 times frying repeat because it is suspected that repeated frying will increase the composition of fatty acids in cooking oil. The analysis of fatty acids was conducted using gas chromatography. Based on these results that the fatty acid components were produced of saturated fatty acids, namely lauric acid, myristic acid, palmitic acid, and stearic acid, whereas unsaturated fatty acids also detected such as elaidic acid, oleic acid, linoleic acid, cis-11-eicosadienoic acid, linolenic acid, and cis-11,14-eicosadienoic acid. The highest saturated fatty acid content in cooking oil before frying is palmitic acid (30.88%), whereas unsaturated fatty acid was oleic acid (35.86%). The highest content of saturated fatty acids in cooking oil has been added turmeric extract before frying is palmitic acid (28.5%), while unsaturated fatty acid of oleic acid was 32.97%.

Keywords: cooking oil; fatty acid; curcumin; chemical; content.

1. Introduction

Cooking oil is one of the foodstuffs consumed by the majority of Indonesia's population with consumption levels reaching more than 2.5 million tons per year, or more than 12 kg/person/year, and also the dominant foodstuffs used by the community to process of feedstock into food made from palm oil [1]. As a food ingredient, palm oil has several advantages over other cooking oils, which contain carotene as an anti-cancer and tocopherol as a source of vitamin E3. In addition, palm oil can be a non-cholesterol cooking oil (low cholesterol levels) and contains fatty acids, which are the main components of fats consisting of saturated and unsaturated fatty acids [2,3]. The main components of saturated fatty acids in palm cooking oil are palmitic acid (C-16), oleic acid (C-18: monounsaturated), and linoleic acid (C-18: polyunsaturated), while the other components are in amounts, few are myristic acid (C-14) and stearic acid (C-18) [4]. Palm oil has a fatty acid composition, which is different from other cooking oils because it contains a composition of saturated acids that is almost the

same as unsaturated fatty acids, namely 50% saturated fatty acids and 50% unsaturated fatty acids [5].

In the community, cooking oil is widely used in food processing because it can function as a medium for conveying heat, adding a savory taste, adding nutritional value and calories in food, texture, and appearance of food becomes more attractive, and dry surface [6,7]. In addition, cooking oil can also be used for various food processing processes and is used in almost all types of food preparation such as frying, sautéing, grilling, baking, curling, rolling, and cooking by means of extrusion [8]. Frying is one way to cook raw food into cooked food using cooking oil. Deep frying processing requires a large amount of cooking oil in order to submerge entirely of food ingredients in cooking oil [5]. This condition encourages to use cooking oil repeatedly. The use of cooking oil the longer and repeatedly, the quality will decrease due to oxidation fatty acid. Cooking oil has been oxidized can cause poisoning and other negative effects on human health, but the tendency is that people still often use cooking oil repeatedly for economic purposes [9,10]. In addition to economic factors, it is also due to an increase in prices of basic necessities due to government policies to raise fuel prices, thus encouraging people both industry and households to use cooking oil repeatedly. In developing countries, there are still many repeated frying using cooking oil repeatedly with economic goals. Cooking oil has become an inseparable part of the modern food processing system so that its safety is very important for health institutions throughout the world to provide health insurance among the public in consuming cooking oil [11].

The quality of cooking oil is determined by its constituent fatty acid components, which are classes of saturated or unsaturated fatty acids. Saturated fatty acids have adverse effects on health; otherwise unsaturated fatty acids are a good source of nutrition for health. Saturated fatty acids have the potential to increase blood cholesterol, while unsaturated fatty acids can reduce blood cholesterol. In the cooking process, the chemical composition of cooking oil used has contained frying foodstuffs of unsaturated fatty acids and other byproducts that can reduce the quality of cooking oil so that it becomes toxic and often carcinogenic [12]. The composition of fatty acids in cooking oil changes physicochemical properties due to the thermal process during frying. The physicochemical properties of cooking oil used repeatedly changed at a frying temperature of 180°C and a frying time of 10 minutes by repeating the frying five times, namely the formation of trans fatty acids (chemical properties) and increased viscosity (physical properties) [13]. Some in vivo research results suggest that consumption of thermally oxidized cooking oil may be unhealthy because it can affect the lipid profile, namely an increase in low-density lipoprotein (LDL), a decrease in high-density lipoprotein (HDL) and an increase in cholesterol levels, a hematological system, white blood cell counts. (WBC), neutrophil and lymphocyte counts, obesity, coronary heart disease (CHD) and cardiovascular disease, increased blood pressure, atherosclerosis, kidney function, and can induce lipid peroxidation and oxidative stress that have been linked to the pathogenesis of various degenerative diseases [14,15]. Consumption of coconut oil produces LDL cholesterol, which is much higher than non-tropical oil [16].

Based on previous studies, the frying food with a deep frying method using a pan for 15 minutes. The results obtained are that the sample contains more unsaturated fatty acids than saturated, ie, palmitic acid is the main saturated fatty acid; oleic acid is the main unsaturated fatty acid with linoleic acid, linolenic acid, and palmitoleic acid in varying amounts [8]. Lim et al. has detected the falsification of fresh palm olein (FPO) with RCO using fatty acid compositions and Fourier-transform infrared (FTIR) spectral analysis combined with

chemometrics [17]. The FPO is added to the electric frying pan (DFT-6000) with a maximum capacity (5.5 L) and heated for about 20 minutes to reach a temperature of 180°C. The results show a tendency to decrease PUFAs, which is consistent with the increasing magnitude of changes in the level of counterfeiting, and this might be a good indicator to detect the occurrence of FPO forgery with RCO. Of the two results of this study, more specific testing of cooking oil without using additional elements.

Especially, the objective in this study is applied cooking oil with additional elements, namely turmeric extract obtained from the turmeric plant (*Curcuma longa*) as one of the sources of natural antioxidants that contain curcumin. Turmeric is a useful source of natural antioxidants agents and can provide significant protection against damage to cooking oil due to free radicals and can also prevent fat peroxidation [18,19]. Curcumin ($C_{21}H_{20}O_6$) in turmeric is an active component, hydrophobic yellow-orange polyphenols derived from turmeric rhizomes, and has been used in food as a stabilizer in jelly or as a natural dye in cheese and as an additive in traditional medicine [20–22]. According to Abriana and Johannes [23] showed that the addition of turmeric extract into cooking oil could reduce the formation of trans fatty acids and extend the time of use of cooking oil; and based on the results of the analysis of trans fatty acid levels, the best treatment is the addition of turmeric extract at a concentration of 0.03%. The objective to be achieved in this research is to compare the composition of fatty acids in cooking oil from repeated frying without added turmeric extract with cooking oil that has been added turmeric extract. The contribution of this research is more towards food safety and health for consuming fried food.

2. Materials and Methods

This study aims to test the composition of fatty acids in cooking oil from repeated frying using an experimental laboratory test with 2 (two) types of treatment, namely cooking oil from frying without adding turmeric extract and frying oil from frying with added turmeric extract with 10 repetitions of frying because it is suspected that repeated frying will increase the composition of fatty acids in cooking oil. The main focus of research is to uncover the phenomenon of cooking oil due to repeated frying by analyzing fatty acid levels using gas chromatography.

2.1. Preparation of turmeric extract.

The use of turmeric extract is a consideration of its function as an antioxidant so that it can inhibit thermal oxidation in cooking oil during frying because it contains curcumin, which is a yellow active component and can be extracted from turmeric rhizome. Turmeric is first selected and cleaned, then cut into small pieces or thinly. Then the turmeric is weighed as much as 100 grams for preparation of extraction. 100 grams of turmeric is dried in an oven at 100°C for 1 hour. After drying, then put into a three-neck flask plus 98% glacial acetic acid solvent that has been diluted with a ratio of 1:1 with a total volume of 300 mL solvent. The heater is turned on, and the return cooler is activated. The zero time of extraction is determined when glacial acetic acid reaches its boiling point (118.1°C) and ends at the specified time for 75 minutes. The extraction results are cooled and filtered using filter paper. The filtrate is distilled while the residue is removed. The filtrate obtained from the extraction was put into a distillation flask to separate the turmeric extract from the solvent. The heater is turned on, and the result is solvent and residue. The residue is dried in an oven at 120°C to remove the residual glacial acetic acid

that is still present in turmeric extract. After that, weighing is done until a constant weight is obtained. Turmeric extract was added to cooking oil before frying food with a concentration of 0.03% [23].

2.2. Frying of food Test.

Food frying is done using the deep frying method by using an electric frying kettle equipped with a temperature and time regulator. The frying process starts by putting fresh cooking oil into the frying boiler as much as 3.5 liters (maximum capacity), then the kettle is heated to a temperature of 180°C. Food is fried until cooked within 10 minutes and made as little as possible stirring to reduce the flow of convection in oil and oxidation reactions due to the aeration process. The analysis was carried out on fresh oil (oil that has not been used for frying foodstuffs) as control and on two oil samples, namely cooking oil from frying without added turmeric extract and cooking oil from frying with added turmeric extract. The oil used for repeating the frying is the same oil (it is not replaced, and no additional volume of fresh oil is made). Frying is repeated 10 times with the same temperature and time of frying. Cooking oil samples were taken immediately after the frying process as much as 200 mL, then the oil in the kettle was allowed to cool down and continued with the next frying which is frying first, second, third, fourth, fifth, sixth, seventh, eighth, ninth and tenth [23]. Samples taken for analysis of fatty acid content are samples from the repetition of the first, fifth, and tenth frying.

2.3. Characterization of Cooking Oil.

First, the cooking oil is hydrolyzed into fatty acids, then transformed into a more volatile ester form. The transformation is carried out by methylation to obtain fatty acid methyl esters (FAME); Furthermore, this FAME was analyzed with GC-2010 (Gas Chromatograph) Plus Serial No. gas chromatography. C11804700336 Shimadzu Corp., using standard methods from The Association of Official Analytical Chemists (AOAC). The analysis starts by injecting of solvent as much as 1.0 μL into the column to obtain a baseline. If the carrier gas flow and heating system are perfect, the peak of the solvent will appear in less than 1 minute. After obtaining the baseline, then proceed by injecting 1 μL of the standard FAME mixture (Supelco TM 37 Component FAME Mix Catalog No. 47885-U, Bellefonte, PA, USA). When all the peaks are out, the prepared sample is injected as much as 1.0 μL. Retention times and peak samples were measured for each component.

3. Results and Discussion

In this study, we produced the component of saturated fatty acids in cooking oil namely lauric acid (C12:0), myristic acid (C14:0), palmitic acid (C16:0), and stearic acid (C18:0) while acids Unsaturated fats such as elaidic acid (C18:1n9t), oleic acid (C18:1n9c), linoleic acid (C18:2n6c), cis-11-eicosenoic acid (C20:1), linolenic acid (C18:3n3), linoleic acid (C18:2n6c), cis-11-eicosenoic acid (C20:1), linolenic acid (C18:3n3), and cis-11,14-eicosadienoic acid (C20:2). The highest saturated fatty acid content in fresh cooking oil (as control) is palmitic acid (C16:0) meanwhile, unsaturated fatty acid is oleic acid (C18:1n9c). The higher content of palmitic acid (C16:0) in cooking oil is the major component of palmitic acid in palm oil [11]. The HPLC analysis has exhibited that cooking oil based on palm oil contains the high saturated fatty acid like palmitic acid 30.88% and unsaturated fatty acids namely oleic acid 35.86%, linoleic acid 10.41%, stearic acid 3.43%, mistic acid 0.76%; lauric acid 0.18%; linolenic acid

0.18%; cis-11-eicosenoic acid 0.14%; elaidic acid 0.09% and cis-11,14-eicosadienoic acid 0.07% (Table 1).

Table 1. Composition of fatty Acids from recycled frying cooking oil.

Treatment	Fatty Acids	Frying Treatment (time) [%]				Standards based on O'Brien (2003) [24]
		0	1	5	10	
Untreated Cooking Oil	**Saturated Fatty Acids**					
	Lauric Acid, C12:0	0.18 ±0.003	0.18 ±0.010	0.19 ±0.015	0.19 ±0.015	0.1-1.0
	Myristic Acid, C14:0	0.76 ±0.010	0.89 ±0.012	0.86 ±0.036	0.82 ±0.017	0.9-1.5
	Palmitic Acid, C16:0	30.88 ±0.080	34.83 ±0.555	34.00 ±1.167	32.90 ±1.795	41.8-46.8
	Stearic Acid, C18:0	3.43 ±0.035	3.75 ±0.115	3.73 ±0.075	3.68 ±0.367	4.5-5.1
	Unsaturated Fatty Acids					
	Elaidic Acid, C18:1n9t	0.09 ±0.010	0.09 ±0.006	0.11 ±0.001	0.11 ±0.001	<1
	Oleic Acid, C18:1n9c	35.86 ±0.145	40.47 ±0.746	40.18 ±0.812	38.52 ±2.807	37.3-40.8
	Linoleic Acid, C18:2n6c	10.41 ±0.02	11.56 ±0.165	11.41 ±0.214	10.61 ±0.735	9.1-11.0
	Cis-11-Eicosenoic Acid, C20:1	0.14 ±0.006	0.13 ±0.006	0.13 ±0.006	0.13 ±0.015	-
	Linolenic Acid, C18:3n3	0.18 ±0.005	0.20 ±0.010	0.19 ±0.003	0.17 ±0.006	<1.5
	Cis-11,14-Eicosedienoic Acid, C20:2	0.07 ±0.001	0.09 ±0.021	0.10 ±0.017	0.09 ±0.015	-
Cooking Oil + 0.03% Turmeric	**Saturated Fatty Acids**					
	Lauric Acid, C12:0	0.14 ±0.001	0.10 ±0.006	0.11 ±0.006	0.11 ±0.012	0.1-1.0
	Myristic Acid, C14:0	0.77 ±0.010	0.75 ±0.016	0.73 ±0.021	0.81 ±0.051	0.9-1.5
	Palmitic Acid, C16:0	28.5 ±0.580	29.49 ±0.640	29.25 ±0.957	28.75 ±3.788	41.8-46.8
	Stearic Acid, C18:0	2.96 ±0.050	3.44 ±0.081	3.47 ±0.090	3.61 ±0.182	4.5-5.1
	Unsaturated Fatty Acids					
	Elaidic Acid, C18:1n9t	0.07 ±0.001	0.09 ±0.006	0.09 ±0.006	0.09 ±0.006	<1
	Oleic Acid, C18:1n9c	32.97 ±0.560	33.24 ±1.025	34.05 ±1.100	35.43 ±1.974	37.3-40.8
	Linoleic Acid, C18:2n6c	8.89 ±0.160	9.74 ±0.211	9.94 ±0.495	10.19 ±0.560	9.1-11.0
	Cis-11-Eicosenoic Acid, C20:1	0.14 ±0.006	0.11 ±0.006	0.12 ±0.001	0.12 ±0.006	-
	Linolenic Acid, C18:3n3	0.18 ±0.003	0.18 ±0.015	0.18 ±0.017	0.18 ±0.012	<1.5
	Cis-11,14-Eicosedienoic Acid, C20:2	0.06 ±0.001	0.05 ±0.010	0.04 ±0.010	0.06 ±0.010	-

In addition, we added the turmeric extract 0.03% into cooking oil to suppress oxidation reaction shows that the high saturated fatty acid such as palmitic acid 28.5% and unsaturated fatty acids content of oleic acid 32.97%, linoleic acid 8.89%, stearic acid 2.96%, myristic acid 0.77%, linolenic acid 0.18%; lauric acid 0.14%, cis-11-eicosenoic acid 0.14%; elaidic acid 0.07% and cis-11,14-eicosadienoic acid 0.06% (Table 1). The composition of most fatty acids in recycled cooking oil (RCO) is in the range according to Codex standards, except for C8:0, C10:0, C11:0, C11:0, trans C18:1, and polyunsaturated fatty acids (PUFAs), C20:5 [17]. According to Awogbemi [25] reported that palm oil contained 87.7% unsaturated fatty acids and 12.3% saturated fatty acids. Based on these results also show the variation of cooking oil used and type of food fried greatly affect the properties and composition of fatty acids. Overall, in fresh cooking oil was contained 63.16% linoleic acid 20.72%, linolenic acid 10.53%, stearic acid 5.26%, and the smallest component was palmitic acid 0.33% [26].

3.1. Saturated fatty acids.

The saturated fatty acid has been investigated into repeated frying cooking oil based on palm oil; we found the lauric acid, myristic acid, palmitic acid, and stearic acid compounds. Certainly, palm oil as feedstock to produce cooking oil contains 92% saturated fatty acids, including 48% lauric acid, myristic acid 20%, and palmitic acid 9%, with monounsaturated fatty acids 6% and polyunsaturated fatty acids 1.7% [27]. Figure 1 extracted from Table 1 to observe the range composition and an upward or downward trend in each composition of organic constituents in cooking oil. Figure 1 was recurring frying oil without added turmeric extract showed that before fried the lauric acid of 0.18% (0 times), first frying 0.18% (1 time), fifth frying 0.19% (5 times) and tenth frying 0.19% (10 times). We also compare each organic constituents in cooking oil with results that have been studied from O'Brien and Richard D. [24] as standard organic constituents in fats and oils. Based on frying treatment, the lauric acid frequency looks to increase; it means that the repetition of a frying treatment can increase the lauric acid compound. Then it is compared with standard 0.1-1.0 shows that do not exceed the specified standard.

Meanwhile, the cooking oil has been added turmeric extract 0.03% contains lauric acid of 0.14% (0 times), 0.10% (1 time), 0.11% (5 times) and 0.11% (10 times). The lauric acid frequency was decreased in the first frying, then increase in the fifth and tenth frying (+0.01). By adding 0.03% turmeric extract can reduce the lauric acid compound, then it is compared with a standard data where it does not exceed the predetermined. The lauric acid is also mostly found in virgin coconut oil (VCO), which consists of 90% medium-chain fatty acids (dominated by lauric acid, which is 45-55% and 10% long-chain fatty acids). If it is compared with oil palm, VCO has a higher of lauric acid content, which is 54.06%, meanwhile in palm oil of 0.10%. Lauric acid plays a role in maintaining health, among others, functions to kill various types of microbes derived from fatty acids, to increase metabolic activity, and protect the body from disease and accelerate healing [28]. Among saturated fatty acids, lauric acid has been shown to contribute the least to fat accumulation [29]. Likewise, myristic acid has not exceeded the predetermined standard. Myristic acid (C14:0) is a fatty acid that is found in palm kernel oil and coconut oil, which can increase low-density lipoprotein (LDL) cholesterol levels, but it is a minor group in food. It is a long-chain saturated fatty acid (14:0) and also one of the fattiest acids found in milk fat (above 10%) [30].

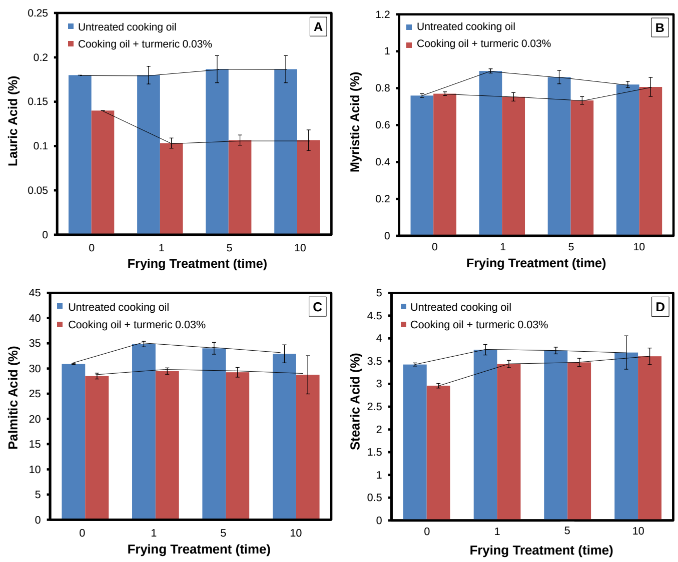


Figure 1. Saturated fatty acids component, (A) Lauric acid, (B) Myristic acid, (C) Palmitic acid and (D) Stearic acid.

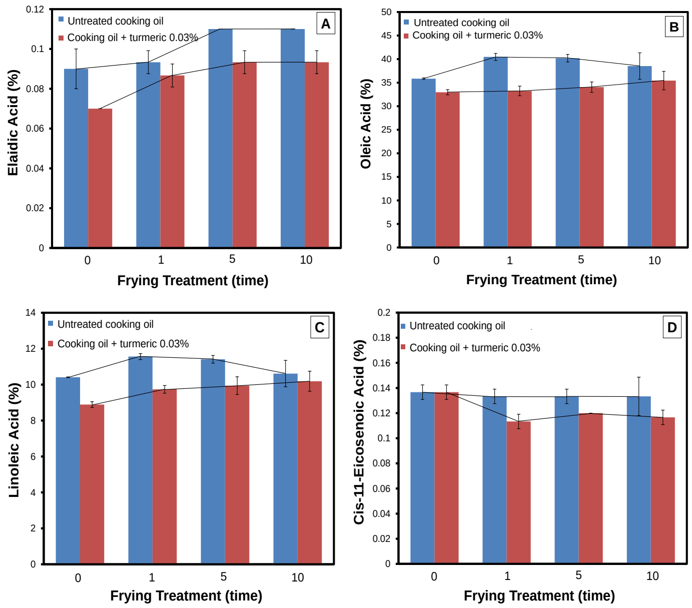
Figure 1C the palmitic acid was quite increased along with the repetition of the frying, and it's still lower than the standard which has been specified (41.8-46.8). Palmitic acid is the main fatty acid in palm oil [31]. Palmitic acid is also the main component of saturated fatty acids in food, which contains vegetable oils 6-10% and can increase LDL cholesterol levels. The presence of palmitic acid in cooking oil can be used as an indicator to detect falsification of fresh palm oil (FPO) with RCO using fatty acid composition analysis (FAC) [17]. Figure 1D also exhibited of the stearic acid compound can be seen that has increased along with the repetition of the frying and compared with a standard in a range of 4.5-5.1 where the saturated fatty acid of stearic acid is still lower from predetermined standards. It is a major component of various types of fat with different amounts, such as animal fat (beef fat) containing 15-20% and only a little in vegetable oil, 4-5% [31]. Stearic acid lowers LDL and HDL cholesterol concentrations when compared with palmitic acid because these fatty acids are quickly converted to monounsaturated fatty acids and oleic acid interesterification of fats rich in palmitic acid or stearic acid does not appear to affect serum lipid fasting and (apo) lipoprotein [32].

Based on saturated fatty acid results and compared with standard fats and oils, we discover that the oil from repeated frying produces saturated fatty acids that do not exceed the specified standard. This means that repeated frying oil based on palm oil is still safe for consumption because of all the saturated fatty acids found within the reasonable standard range, though that can raise cholesterol levels (myristic acid and palmitic acid). In vegetable oils such as palm oil is dominated by more carbon atoms, whereas in animal oils are odd carbon atoms and contain more polyunsaturated fatty acids (PUFA) [33]. Cooking oil with high saturated fatty acid content will affect the stability of food items that are fried during frying [34,35]. In addition, the high content of fatty acids causes oil to be easily damaged during cooking processing because the oil will be heated continuously at high temperatures and direct contact with oxygen in the surrounding air, which facilitates the oxidation reaction to the oil. According to Baba-Moussa et al. [12], an increase in temperature followed by a long heating time indicates that an increase in the fatty acid component forms triglycerides. The result of triglyceride hydrolysis will produce saturated and unsaturated fatty acids based on the presence or absence of carbon chain double bonds in the molecule.

3.2. Unsaturated fatty acids.

The presence of organic constituents in repeated frying oil has been examined that it contains elaidic acid, oleic acid, linoleic acid, cis-11-eicosenoic acid, linolenic acid, and cis-11,14-eicosadienoic acid. Based on Figure 2A the content of untreated cooking oil from elaidic acid showed that 0.09% (0 times), 0.09% (1 time), 0.11% (5 times) and 0.11% (10 times), while the frying oil added 0.03% turmeric extract showed the treatment before frying 0.07% (0 times), 0.09% (1 time), 0.09% (5 times) and 0.09% (10 times). If seen from the frequency of elaidic acid (Figure 2A) that repeated frying can increase the level of elaidic acid and compare with standard <1 that it does not exceed the specified standard. This is because trans fatty acids (TFA) in elaidic acid are unsaturated fatty acids with at least one double bond in the form of trans configuration that can occur naturally from ruminants-based meat and dairy products, or artificially through partial hydrogenation of vegetable oils in industry food processing [36]. Sartika also reported that trans fatty acids (elaidate) were only formed after the second repetition of deep-frying, and their levels increased with the repeated use of oil. Based on the initial formation of trans fatty acids, the frying process should be done on medium heat (<200°C), and the cooking oil used should not exceed 2 (two) repetitions. Not so in the oleic acid compound (Figure 2B) shows a tendency to vary, if it is compared with the standard of 37.3-40.8. Whereas the recycled frying oil added with 0.03% turmeric extract showed an increase along with the repetition of the frying and when compared with the standard 37.3-40.8. These results indicate that oleic acid is still lower than the standard value.

Furthermore, the content of linoleic acid (Figure 2C) in untreated cooking oil showed the same conditions varying when compared with the standard of 9.1-11.0. One that met the standard was the treatment before the tenth frying and frying, while those that do not meet the standards in the first and fifth frying treatment. Then, it compared with frying cooking oil added 0.03% turmeric extract showed an increase along with the repetition of the frying and compared with the standard the first, fifth, and tenth frying have met the standards. Meanwhile, which did not meet the standards in the treatment before the addition of turmeric extract such as the first and fifth frying. This result showed that repeated frying could increase the levels of linoleic acid in the oil from repeated frying by adding 0.03% turmeric extract. It is due to the conjugation of linolenic acid isomer refers to a group of positions and geometrical isomers of omega-3-α-linolenic acid essential acids (cis-9, cis-12, cis-15 C18: 3; ALA) [37,38].



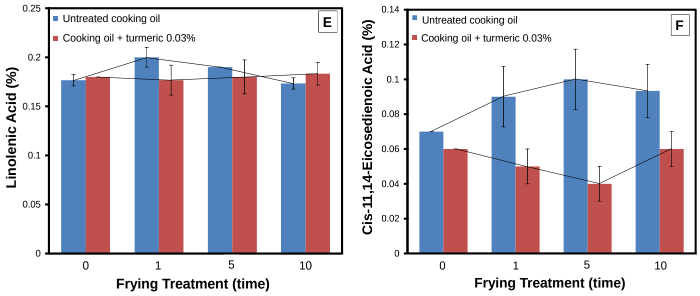


Figure 2. Unsaturated fatty acids component (A) elaidic acid, (B) oleic acid, (C) linoleic acid, (D) cis-11-eicosenoic acid, (E) linolenic acid, and (F) cis-11,14-eicosadienoic acid.

The content of cis-11-eicosenoic acid (Figure 2D) in untreated cooking oil and added 0.03% turmeric extract had decreased levels caused by slow oxidation reactions against cis-11-eicosenoic acid. The frequency of linolenic acid (Figure 2E) in unprocessed cooking oil shows a variable trend. At the beginning of the frying (1 time), there was an increase compared to those not treated, but over time the frying duration decreases. In otherwise, by adding turmeric extract shows a quite static level before frying to the tenth repetition treatment. It shows that turmeric extract can suppress the occurrence oxidation reaction. Meanwhile, Figure 2F depicts cis-11-14-eicosadienoic acid has increased in untreated cooking oil, while the unique by adding turmeric extract dramatically decrease levels. It is concluded cooking oil without treatment has shown increase unsaturated acid levels. The performance of turmeric extract has quite demonstrated efficiency in suppressing chemical reactions during frying treatment [39]. In addition, turmeric extract can function as an antioxidant so that it can inhibit thermal oxidation in cooking oil during repeated frying. This will affect the composition of fatty acids contained in cooking oil. According to Kim and Clifton [40] showed that curcumin (diferuloylmethane) is the main secondary metabolite in turmeric extract, which is beneficial to the human body as antioxidant and anti-inflammatory properties. Curcumin, as a bioactive component, has been shown to be a broad biological action. To date, it has been reported that natural colored extracts are isolated from turmeric by various methods such as maceration, digestion, microwave, and infusion [21]. Turmeric varieties studied by Tanvir et al. [18] is a useful source of natural antioxidants and can provide protection against free radical damage. Curcumin can be used as a food additive and is also good for use as conventional medicine [41].

4. Conclusions

This study reports the chemical composition of cooking oil consisting of saturated fatty acids, such as lauric acid, myristic acid, palmitic acid, and stearic acid. Whereas, the unsaturated fatty acids of elaidic acid, oleic acid, linoleic acid, cis-11-eicosedienoic acid, linolenic acid, and cis-11,14-eicosedienoic acid. The highest saturated fatty acid levels in cooking oil before frying, are palmitic acid of 30.88%, whereas unsaturated fatty acids, namely oleic acid of 35.86%. ~~The highest saturated fatty acid content in the oil which has added turmeric extract before frying is palmitic acid of 28.5%, while unsaturated fatty acids like oleic acid of 32.97%.~~ The high saturated fatty acid content in oil cooking before the frying process is palmitic acid of 30.88%, whereas the unsaturated fatty acid is oleic acid of 32.97%. Turmeric

Commented [A3]: Incomplete. Please clarify extract added to cooking oil can function as an anticosidan so that it can inhibit thermal oxidation in cooking oil during repeated frying. The treatment of repeated frying affects the fatty acids contained in repeated cooking oils, both saturated fatty acids and unsaturated fatty acids.

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Conflicts of Interest

The authors declare no conflict of interest.

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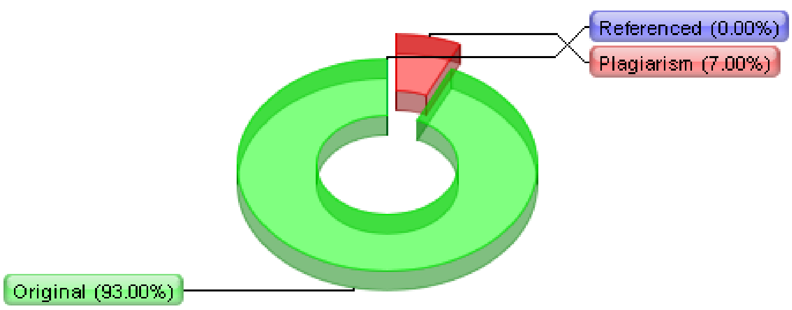

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https://doi.org/10.33263/BRIAC00.000000
https://doi.org/10.33263/BRIAC00.000000Identification of Organic Constituents in Cooking Oil by Adding Turmeric as a Potential Antioxidant AgentAndi Abriana 1, *, Hamsina Hamsina 2, Suriana Laga 1, Maulidiyah Maulidiyah 3,*1

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Department of Chemical Engineering, Faculty of Engineering, Universitas Bosowa Makassar, Kota Makassar 90231, South Sulawesi - Indonesia.3
Department of Chemistry, Faculty of Mathematics and Natural sciences, Universitas Halu Oleo, Kota Kendari 93231 - Southeast Sulawesi - Indonesia*
Correspondence: andi.abriana510@gmail.com (A.A.); maulid06@yahoo.com (M.M.); Scopus Author ID 56648049800Received: date; Revised: date; Accepted: date; Published: dateAbstract:
The objective of this study to compare the fatty acids composition in cooking oil from repeated frying without added turmeric extract and added. The research design is testing the composition of fatty acids in repeated cooking oil using two types of treatment, namely cooking oil from frying without adding turmeric extract and cooking oil from frying with 0.03% turmeric extract added with 10 times frying repeat because it is suspected that repeated frying will increase the composition of fatty acids in cooking oil. The analysis of fatty acids was conducted using gas chromatography. Based on these results that the fatty acid components were produced of saturated fatty acids, namely lauric acid, myristic acid, palmitic acid, and stearic acid, whereas unsaturated fatty acids also detected such as elaidic acid, oleic acid, linoleic acid, cis-11-eicosadienoic acid, linolenic acid, and cis-11,14-eicosadienoic acid. The highest saturated fatty acid content in cooking oil before frying is palmitic acid (30.88%), whereas unsaturated fatty acid was oleic acid (35.86%).

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The highest content of saturated fatty acids

in cooking oil has been added turmeric extract before frying is palmitic acid (28.5%), while unsaturated fatty acid of oleic acid was 32.97%. Keywords: cooking oil; fatty acid; curcumin; chemical; content.1. Introduction
Cooking oil is one of the foodstuffs consumed by the majority of Indonesia's population with consumption levels reaching more than 2.5 million tons per year, or more than 12 kg/person/year, and also the dominant foodstuffs used by the community to process of feedstock into food made from palm oil [1]. As a food ingredient, palm oil has several advantages over other cooking oils, which contain carotene as an anti-cancer and tocopherol as a source of vitamin E3. In addition, palm oil can be a non-cholesterol cooking oil (low cholesterol levels) and contains fatty acids
, which are the main components of fats consisting

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of saturated and unsaturated fatty acids

[2,3]. The main components of saturated fatty acids in palm cooking oil are palmitic acid (C-16),

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oleic acid (C-18: monounsaturated)

, and linoleic acid (C-18: polyunsaturated), while the other components are in amounts, few are myristic acid (C-14) and stearic acid (C-18) [4]. Palm oil has a fatty acid composition, which is different from other cooking oils because it contains a composition of saturated acids that is almost the same as unsaturated fatty acids, namely 50% saturated fatty acids and 50% unsaturated fatty acids [5].In the community, cooking oil is widely used in food processing because it can function as a medium for conveying heat, adding a savo
ry taste, adding nutritional value and calories in food, texture, and appearance of food becomes more attractive, and dry surface [6,7]. In addition, cooking oil can also be used for various food processing processes and is

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used in almost all types of

food preparation such as frying, sautéing, grilling, baking, curling, rolling, and cooking by means of extrusion [8]. Frying is one way to cook raw food into cooked food using cooking oil. Deep frying processing requires a large amount of cooking oil in order to submerge entirely of food ingredients in cooking oil [5]. This condition

encourages to use cooking oil repeatedly. The use of cooking oil the longer and more often (repeatedly), the quality will decrease due to oxidation fatty acid. Cooking oil has been oxidized can cause poisoning and other negative effects on human health, but the tendency is that people still often use cooking oil repeatedly for economic purposes [9,10]. In addition to economic factors, it is also due to an increase in prices of basic necessities due to government policies to raise fuel prices, thus encouraging people both industry and households to use cooking oil repeatedly. In developing countries, there are still many repeated frying using cooking oil repeatedly with economic goals. Cooking oil has become an inseparable part of the modern food processing system so that its safety is very important for health institutions throughout the world to provide health insurance among the public in consuming cooking oil [11].The quality of cooking oil is determined by its constituent fatty acid components, which are classes of saturated or unsaturated fatty acids. Saturated fatty acids have adverse effects on health
; otherwise unsaturated fatty acids are a good source of nutrition for health. Saturated fatty acids have the potential to increase blood cholesterol, while unsaturated fatty acids can reduce blood cholesterol. In the cooking process, the chemical composition of cooking oil used has contained frying foodstuffs of unsaturated fatty acids and other byproducts that can reduce the quality of cooking oil so that it becomes toxic and often carcinogenic [12]. The composition of fatty acids in cooking oil changes physicochemical properties due to the thermal process during frying. The physicochemical properties of cooking oil used repeatedly changed at a frying temperature of 180'C and a frying time of 10 minutes by repeating the frying five times, namely the formation of trans fatty acids (chemical properties) and increased viscosity (physical properties) [13]. Some in vivo research results suggest that consumption of thermally oxidized cooking oil may be unhealthy because it can affect the lipid profile, namely an increase in low-density lipoprotein (LDL), a decrease in high-density lipoprotein (HDL) and an increase in cholesterol levels, a hematological system, white blood cell counts. (WBC), neutrophil and lymphocyte counts, obesity, coronary heart disease (CHD) and cardiovascular disease, increased blood pressure, atherosclerosis, kidney function, and can induce lipid peroxidation and oxidative stress that have been linked to the pathogenesis of various degenerative diseases [14,15]. Consumption of coconut oil produces LDL cholesterol, which is much higher than non-tropical oil [16].Based on previous studies, the frying food with a deep frying method using a pan for 15 minutes. The results obtained are that the sample contains more unsaturated fatty acids than saturated, ie
, palmitic acid is the main saturated fatty acid; oleic acid

is the main unsaturated fatty acid

with linoleic acid, linolenic acid, and palmitoleic acid in varying amounts [8]. Lim et al. has detected the falsification of fresh palm olein (FPO) with RCO using fatty acid compositions and Fourier-transform infrared (FTIR) spectral analysis combined with chemometrics [17]. The FPO is added to the electric frying pan (DFT-6000) with a maximum capacity (5.5 L) and heated for about 20 minutes to reach a temperature of 180'C. The results show a tendency to decrease PUFAs, which is consistent with the increasing magnitude of changes in the level of counterfeiting, and this might be a good indicator to detect the occurrence of FPO forgery with RCO. Of the two results of this study, more specific testing of cooking oil without using additional elements. Especially, the objective in this study is applied cooking oil with additional elements, namely turmeric extract obtained from the turmeric plant (Curcuma longa) as one of the sources of natural antioxidants that contain curcumin. Turmeric is a useful source of natural antioxidants agent
s and can provide significant protection against damage to cooking oil due to free radicals and can also prevent fat peroxidation [18,19]. Curcumin ($C_{21}H_{20}O_6$) in turmeric is an active component, hydrophobic yellow-orange polyphenols derived from turmeric rhizomes, and has been used in food as a stabilizer in jelly or as a natural dye in cheese and as an additive in traditional medicine [20-22]. According to Abriana and Johannes [23] showed that the addition of turmeric extract into cooking oil could reduce the formation of trans fatty acids and extend the time of use of cooking oil; and based on the results of the analysis of trans fatty acid levels, the best treatment is the addition of turmeric extract at a concentration of 0.03%. The objective to be achieved in this research is to compare the composition of fatty acids in cooking oil from repeated frying without added turmeric extract with cooking oil that has been added turmeric extract. The contribution of this research is more towards food safety and health for consuming fried food.2. Materials and Methods
This study aims to test the composition of fatty acids in cooking oil from repeated frying using a
n experimental laboratory test with 2 (two) types of treatment, namely cooking oil from frying without adding turmeric extract and frying oil from frying with added turmeric extract with 10 repetitions of frying because it is suspected that repeated frying will increase the composition of fatty acids in cooking oil. The main focus of research is to uncover the phenomenon of cooking oil due to repeated frying by analyzing fatty acid levels using gas chromatography.Preparation of turmeric extract
.The use of turmeric extract is a consideration of its function as an antioxidant so that it can inhibit thermal oxidation in cooking oil during frying because it contains curcumin
, which is a yellow active component and can be extracted from turmeric rhizome. Turmeric is first selected and cleaned, then cut into small pieces or thinly. Then the turmeric is weighed as much as 100 grams for preparation of extraction. 100 grams of turmeric is dried in an oven at 100'C for 1 hour. After drying, then put into a three-neck flask plus 98% glacial acetic acid solvent that has been diluted with a ratio of 1:1 with a total volume of 300 mL solvent. The heater is turned on, and the return cooler is activated. The zero time of extraction is determined

when glacial acetic acid reaches its boiling point (118.1'C) and ends at the specified time for 75 minutes. The extraction results are cooled and filtered using filter paper. The filtrate is distilled while the residue is removed. The filtrate obtained from the extraction was put into a distillation flask to separate the turmeric extract from the solvent. The heater is turned on, and the result is solvent and residue. The residue is dried in an oven at 120'C to remove the residual glacial acetic acid that is still present in turmeric extract. After that, weighing is done until a constant weight is obtained. Turmeric extract was added to cooking oil before frying food with a concentration of 0.03% [23].Frying of food Test.
Food frying is done using the deep frying method by using an electric frying kettle equipped with a temperature and time regulator. The frying process starts by putting fresh cooking oil into the frying boiler as much as 3.5 liters (maximum capacity), then the kettle is heated to a temperature of 180'C. Food is fried until cooked within 10 minutes and made as little as possible stirring to reduce the flow of convection in oil and oxidation reactions

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due to the aeration process. The

analysis was carried out on fresh oil (oil that has not been used for frying foodstuffs) as control and on two oil samples, namely cooking oil from frying without added turmeric extract and cooking oil from frying with added turmeric extract. The oil used for repeating the frying is the same oil (it is not replaced, and no additional volume of fresh oil is made). Frying is repeated 10 times with the same temperature and time of frying. Cooking oil samples were taken immediately after the frying process as much as 200 mL, then the oil in the kettle was allowed to cool down and continued with the next frying which is frying first, second, third, fourth, fifth, sixth, seventh, eighth, ninth and tenth [23]. Samples taken for analysis of fatty acid content are samples from the repetition of the first, fifth, and tenth frying.2.3. Characterization of Cooking Oil. First, the cooking oil is hydrolyzed into fatty acids, then transformed into a more volatile ester form. The transformation is carried out by methylation to obtain fatty acid methyl esters (FAME); Furthermore, this FAME was analyzed with GC-2010 (Gas Chromatograph) Plus Serial No. gas chromatography. C11804700336 Shimadzu Corp., using standard methods from

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The Association of Official Analytical Chemists (AOAC).

The analysis starts by injecting of solvent as much as 1.0 μL into the column to obtain a baseline. If the carrier gas flow and heating system are perfect, the peak of the solvent will appear in less than 1 minute. After obtaining the baseline, then proceed by injecting 1 μL of the standard FAME mixture (Supelco TM 37 Component FAME Mix Catalog No. 47885-U, Bellefonte, PA, USA). When all the peaks are out, the prepared sample is injected as much as 1.0 uL. Retention times and peak samples were measured for each component.
3. Results and Discussion
In this study, we produced the component of saturated fatty acids in cooking oil namely lauric acid (C12:0), myristic acid (C14:0), palmitic acid (C16:0)

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, and stearic acid (C18:0

) while acids Unsaturated fats such as elaidic acid (C18:1n9t), oleic acid (C18:1n9c), linoleic acid (C18:2n6c), cis-11-eicosenoic acid (C20:1), linolenic acid (C18:3n3), linoleic acid (C18:2n6c), cis-11-eicosenoic acid (C20:1), linolenic acid (C18:3n3), and cis-11,14-eicosadienoic acid (C20:2). The highest saturated fatty acid content in fresh cooking oil (as control) is palmitic acid (C16:0) meanwhile
, unsaturated fatty acid is oleic acid (C18:1n9c). The higher content of palmitic acid (C16:0) in cooking oil is the major component of palmitic acid in palm oil [11]. The HPLC analysis has exhibited that cooking oil based on palm oil contains the high saturated fatty acid like palmitic acid 30.88% and unsaturated fatty acids namely oleic acid 35.86%, linoleic acid 10.41%, stearic acid 3.43%, mistic acid 0.76%; lauric acid 0.18%; linolenic acid 0.18%; cis-11-eicosenoic acid 0.14%; elaidic acid 0.09% and cis-11,14-eicosadienoic acid 0.07% (Table 1). Table 1. Composition of fatty Acids from recycled frying cooking oil.Treatment
Fatty Acids
Frying Treatment (time) [%]
Standards based on O'Brien (2003) [24] 0
1
5
10
Untreated Cooking Oil
Saturated Fatty Acids
Lauric Acid, C12:0
0.18 ±0.003
0.18 ±0.010
0.19 ±0.015
0.19 ±0.015
0.1-1.0
Myristic Acid, C14:0

0.76 ±0.010
0.89 ±0.012
0.86 ±0.036
0.82 ±0.017
0.9-1.5
Palmitic Acid, C16:0
30.88 ±0.080
34.83 ±0.555
34.00 ±1.167
32.90 ±1.795
41.8-46.8
Stearic Acid, C18:0
3.43 ±0.035
3.75 ±0.115
3.73 ±0.075
3.68 ±0.367
4.5-5.1
Unsaturated Fatty Acids
Elaidic Acid, C18:1n9t
0.09 ±0.010
0.09 ±0.006
0.11 ±0.001
0.11 ±0.001
1
Oleic Acid, C18:1n9c
35.86 ±0.145
40.47 ±0.746
40.18 ±0.812
38.52 ±2.807
37.3-40.8
Linoleic Acid, C18:2n6c
10.41 ±0.02
11.56 ±0.165
11.41 ±0.214
10.61 ±0.735
9.1-11.0
Cis-11-Eicosenoic Acid, C20:1
0.14 ±0.006
0.13 ±0.006
0.13 ±0.006
0.13 ±0.015
-
Linolenic Acid, C18:3n3
0.18 ±0.005
0.20 ±0.010
0.19 ±0.003
0.17 ±0.006
1.5
Cis-11,14-Eicosedienoic Acid, C20:2
0.07 ±0.001
0.09 ±0.021
0.10 ±0.017
0.09 ±0.015
-
Cooking Oil + 0.03% Turmeric
Saturated Fatty Acids
Lauric Acid, C12:0
0.14 ±0.001
0.10 ±0.006
0.11 ±0.006
0.11 ±0.012
0.1-1.0
Myristic Acid, C14:0
0.77 ±0.010
0.75 ±0.016
0.73 ±0.021

0.81 ±0.051
0.9-1.5
Palmitic Acid, C16:0
28.5 ±0.580
29.49 ±0.640
29.25 ±0.957
28.75 ±3.788
41.8-46.8
Stearic Acid, C18:0
2.96 ±0.050
3.44 ±0.081
3.47 ±0.090
3.61 ±0.182
4.5-5.1
Unsaturated Fatty Acids
Elaidic Acid, C18:1n9t
0.07 ±0.001
0.09 ±0.006
0.09 ±0.006
0.09 ±0.006
1
Oleic Acid, C18:1n9c
32.97 ±0.560
33.24 ±1.025
34.05 ±1.100
35.43 ±1.974
37.3-40.8
Linoleic Acid, C18:2n6c
8.89 ±0.160
9.74 ±0.211
9.94 ±0.495
10.19 ±0.560
9.1-11.0
Cis-11-Eicosenoic Acid, C20:1
0.14 ±0.006
0.11 ±0.006
0.12 ±0.001
0.12 ±0.006
-
Linolenic Acid, C18:3n3
0.18 ±0.003
0.18 ±0.015
0.18 ±0.017
0.18 ±0.012
1.5
Cis-11,14-Eicosedienoic Acid, C20:2
0.06 ±0.001
0.05 ±0.010
0.04 ±0.010
0.06 ±0.010
-

In addition, we added the turmeric extract 0.03% into cooking oil to suppress oxidation reaction shows that the high saturated fatty acid such as palmitic acid 28.5% and unsaturated fatty acids content of oleic acid 32.97%, linoleic acid 8.89%, stearic acid 2.96%, myristic acid 0.77%, linolenic acid 0.18%; lauric acid 0.14%, cis-11-eicosenoic acid 0.14%; elaidic acid 0.07% and cis-11,14-eicosadienoic acid 0.06% (Table 1). The composition of most fatty acids in recycled cooking oil (RCO) is in the range according to Codex standards, except for C8:0, C10:0, C11:0, C11:0, trans C18:1, and polyunsaturated fatty acids (PUFAs), C20:5 [17]. According to Awogbemi [25] reported that palm oil contained 87.7% unsaturated fatty acids and 12.3% saturated fatty acids. Based on these results also show the variation of cooking oil used and type of food fried greatly affect the properties and composition of fatty acids. Overall, in fresh cooking oil was contained 63.16% linoleic acid 20.72%, linolenic acid 10.53%, stearic acid 5.26%
, and the smallest component was palmitic acid 0.33% [26].3.1. Saturated fatty acids.The saturated fatty acid has been investigated into repeated frying cooking oil based on palm oil
; we found the lauric acid, myristic acid, palmitic acid, and stearic acid compounds. Certainly, palm oil as feedstock to produce cooking oil contains 92% saturated fatty acids, including 48% lauric acid, myristic acid 20%, and palmitic acid 9%, with monounsaturated fatty acids 6% and polyunsaturated fatty acids 1.7% [27]. Figure 1

extracted from Table 1 to observe the range composition and an upward or downward trend in each composition of organic constituents in cooking oil. Figure 1 was recurring frying oil without added turmeric extract showed that before fried the lauric acid of 0.18% (0 times), first frying 0.18% (1 time), fifth frying 0.19% (5 times) and tenth frying 0.19% (10 times). We also compare each organic constituents in cooking oil with results that have been studied from O'Brien and Richard D. [24] as standard organic constituents in fats and oils. Based on frying treatment, the lauric acid frequency looks to increase; it means that the repetition of a frying treatment can increase the lauric acid compound. Then it is compared with standard 0.1-1.0 shows that do not exceed the specified standard. Meanwhile, the cooking oil has been added turmeric extract 0.03% contains lauric acid of 0.14% (0 times), 0.10% (1 time), 0.11% (5 times) and 0.11% (10 times). The lauric acid frequency was decreased in the first frying, then increase in the fifth and tenth frying (+0.01). By adding 0.03% turmeric extract can reduce the lauric acid compound, then it is compared with a standard data where it does not exceed the predetermined. The lauric acid is also mostly found in virgin coconut oil (VCO)
, which consists of 90% medium-chain fatty acids (dominated by lauric acid, which is 45-55% and 10% long-chain fatty acids). If it is compared with oil palm, VCO has a higher of lauric acid content, which is 54.06%, meanwhile in palm oil of 0.10%. Lauric acid plays a role in maintaining health, among others, functions to kill various types of microbes derived from fatty acids, to increase metabolic activity, and protect the body from disease and accelerate healing [28]. Among saturated fatty acids, lauric acid has been shown to contribute the least to fat accumulation [29]. Likewise, myristic acid has not exceeded the predetermined standard. Myristic acid (C14:0) is a fatty acid that is found in palm kernel oil and coconut oil, which can increase low-density lipoprotein (LDL) cholesterol levels, but it is a minor group in food. It is a long-chain saturated fatty acid (14:0) and also one of the fattiest acids found in milk fat (above 10%) [30].Figure 1.
Saturated fatty acids component, (A) Lauric acid, (B) Myristic acid, (C) Palmitic acid and (D) Stearic acid.Figure 1C the palmitic acid was quite increased along with the repetition of the frying
, and it's still lower than the standard which has been specified (41.8-46.8). Palmitic

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acid is the main fatty acid

in palm oil [31]. Palmitic acid is also the main component of saturated fatty acids in food, which contains vegetable oils 6-10% and can increase LDL cholesterol levels. The presence of palmitic acid in cooking oil can be used as an indicator to detect falsification of fresh palm oil (FPO) with RCO using fatty acid composition analysis (FAC) [17]. Figure 1D also exhibited of the stearic acid compound can be seen that has increased along with the repetition of the frying and compared with a standard in a range of 4.5-5.1 where the saturated fatty acid of stearic acid is still lower from predetermined standards. It is a major component of various types of fat with different amounts, such as animal fat (beef fat) containing 15-20% and only a little in vegetable oil, 4-5% [31]. Stearic acid lowers LDL and HDL cholesterol concentrations when compared with palmitic acid because these fatty acids are quickly converted to monounsaturated fatty acids and oleic acid interesterification of fats rich in palmitic acid or stearic acid does not appear to affect serum lipid fasting and (apo) lipoprotein [32]. Based on saturated fatty acid results and compared with standard fats and oils, we discover that the oil from repeated frying produces saturated fatty acids that do not exceed the specified standard. This means that repeated frying oil based on palm oil is still safe for consumption because of all the saturated fatty acids found within the reasonable standard range, though that can raise cholesterol levels (myristic acid and palmitic acid). In vegetable oils such as palm oil is dominated by more carbon atoms, whereas in animal oils are odd carbon atoms and contain more polyunsaturated fatty acids (PUFA) [33]. Cooking oil with high saturated fatty acid content will affect the stability of food items that are fried during frying [34,35]. In addition, the high content of fatty acids causes oil to be easily damaged during cooking processing because the oil will be heated continuously at high temperatures and direct contact with oxygen in the surrounding air
, which facilitates the oxidation reaction to the oil. According to Baba-Moussa et al. [12], an increase in temperature followed by a long heating time indicates that an increase in the fatty acid component forms triglycerides. The result of triglyceride hydrolysis will produce saturated and unsaturated fatty acids based on the presence or absence of carbon chain double bonds in the molecule.3.2. Unsaturated fatty acids.The presence of organic constituents in repeated frying oil has been examined that it contains elaidic acid, oleic acid, linoleic acid, cis-11-eicosenoic acid, linolenic acid, and cis-11,14-eicosadienoic acid. Based on Figure 2A the content of untreated cooking oil from elaidic acid showed that 0.09% (0 times), 0.09% (1 time), 0.11% (5 times) and 0.11% (10 times), while the frying oil added 0.03% turmeric extract showed the treatment before frying 0.07% (0 times), 0.09% (1 time), 0.09% (5 times) and 0.09% (10 times). If seen from the frequency of elaidic acid (Figure 2A) that repeated frying can increase the level of elaidic acid and compare with standard 1 that it does not exceed the specified standard. This is because trans fatty acids (TFA) in elaidic acid are

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unsaturated fatty acids with at least one double bond in the

form of trans configuration that can occur naturally from ruminants-based meat and dairy products, or artificially through partial hydrogenation of vegetable oils in industry food processing [36]. Sartika also reported that trans fatty acids (elaidate) were only formed after the second repetition of deep-frying, and their levels increased with the repeated use of oil. Based on the initial formation of trans fatty acids, the frying process should be done on medium heat (200'C), and the cooking oil used should not exceed 2 (two) repetitions. Not so in the oleic acid

compound (Figure 2B) shows a tendency to vary, if it is compared with the standard of 37.3-40.8. Whereas the recycled frying oil added with 0.03% turmeric extract showed an increase along with the repetition of the frying and when compared with the standard 37.3-40.8. These results indicate that oleic acid is still lower than the standard value.Furthermore, the content of linoleic acid (Figure 2C) in untreated cooking oil showed the same conditions varying when compared with the standard of 9.1-11.0. One that met the standard was the treatment before the tenth frying and frying, while those that do not meet the standards in the first and fifth frying treatment. Then, it compared with frying cooking oil added 0.03% turmeric extract showed an increase along with the repetition of the frying and compared with the standard the first, fifth
, and tenth frying have met the standards. Meanwhile, which did not meet the standards in the treatment before the addition of turmeric extract such as the first and fifth frying. This result showed that repeated frying could increase the levels of linoleic acid in the oil from repeated frying by adding 0.03% turmeric extract. It is due to the conjugation of linolenic acid isomer refers to a group of positions and geometrical isomers of omega-3-α-linolenic acid essential acids (

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cis-9, cis-12, cis-15

C18: 3; ALA) [37,38].Figure 2.
Unsaturated fatty acids component (A) elaidic acid, (B) oleic acid, (C) linoleic acid, (D) cis-11-eicosenoic acid, (E) linolenic acid, and (F) cis-11,14-eicosadienoic acid.The content of cis-11-eicosenoic acid (Figure 2D) in untreated cooking oil and added 0.03% turmeric extract had decreased levels caused by slow oxidation reactions against cis-11-eicosenoic acid. The frequency of linolenic acid (Figure 2E) in unprocessed cooking oil shows a variable trend. At the beginning of the frying (1 time), there was an increase compared to those not treated, but over time the frying duration decreases. In otherwise, by adding turmeric extract shows a quite static level before frying to the tenth repetition treatment. It shows that turmeric extract can suppress the occurrence oxidation reaction. Meanwhile, Figure 2F depicts cis-11-14-eicosadienoic acid has increased in untreated cooking oil, while the unique by adding turmeric extract dramatically decrease levels. It is concluded cooking oil without treatment has shown increase unsaturated acid levels. The performance of turmeric extract has quite demonstrated efficiency in suppressing chemical reactions during frying treatment [39]. In addition, turmeric extract can function as an antioxidant so that it can inhibit thermal oxidation in cooking oil during repeated frying. This will affect the composition of fatty acids contained in cooking oil. According to Kim and Clifton [40] showed that curcumin (diferuloylmethane) is the main secondary metabolite in turmeric extract, which is beneficial to the human body as antioxidant and anti-inflammatory properties. Curcumin, as a bioactive component, has been shown to be a broad biological action. To date, it has been reported that natural colored extracts are isolated from turmeric by various methods such as maceration, digestion, microwave, and infusion [21]. Turmeric varieties studied by Tanvir et al. [18] is a useful source of natural antioxidants and can provide protection against free radical damage. Curcumin can be used as a food additive and is also good for use as conventional medicine [41].4.
Conclusions
This study reports the chemical composition of cooking oil consisting of saturated fatty acids, such as lauric acid, myristic acid, palmitic acid, and stearic acid. Whereas, the unsaturated fatty acids of elaidic acid, oleic acid, linoleic acid, cis-11-eicosedienoic acid, linolenic acid, and cis-11,14-eicosedienoic acid. The highest saturated fatty acid levels in cooking oil before frying
, are palmitic acid of 30.88%, whereas unsaturated fatty acids, namely oleic acid of 35.86%. The highest saturated

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fatty acid content in the oil

which has added turmeric extract before frying is palmitic acid of 28.5%, while unsaturated fatty acids like oleic acid of 32.97%. Turmeric extract added to cooking oil can function as an anticosidan so that it can inhibit thermal oxidation in cooking oil during repeated frying. The treatment of repeated frying affects the fatty acids contained in repeated cooking oils, both saturated fatty acids and unsaturated fatty acids.Funding
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, in conducting this research.Conflicts

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Identification of Organic Constituents in Cooking Oil by Adding Turmeric as a Potential Antioxidant Agent

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Abstract: The objective of this study to compare the fatty acids composition in cooking oil from repeated frying without added turmeric extract and added. The research design is testing the composition of fatty acids in repeated cooking oil using two types of treatment, namely cooking oil from frying without adding turmeric extract and cooking oil from frying with 0.03% turmeric extract added with 10 times frying repeat because it is suspected that repeated frying will increase the composition of fatty acids in cooking oil. The analysis of fatty acids was conducted using gas chromatography. Based on these results that the fatty acid components were produced of saturated fatty acids, namely lauric acid, myristic acid, palmitic acid, and stearic acid, whereas unsaturated fatty acids also detected such as elaidic acid, oleic acid, linoleic acid, cis-11-eicosadienoic acid, linolenic acid, and cis-11,14-eicosadienoic acid. The highest saturated fatty acid content in cooking oil before frying is palmitic acid (30.88%), whereas unsaturated fatty acid was oleic acid (35.86%). The highest content of saturated fatty acids in cooking oil has been added turmeric extract before frying is palmitic acid (28.5%), while unsaturated fatty acid of oleic acid was 32.97%.

Keywords: cooking oil; fatty acid; curcumin; chemical; content.

1. Introduction

Cooking oil is one of the foodstuffs consumed by the majority of Indonesia's population with consumption levels reaching more than 2.5 million tons per year, or more than 12 kg/person/year, and also the dominant foodstuffs used by the community to process of feedstock into food made from palm oil [1]. As a food ingredient, palm oil has several advantages over other cooking oils, which contain carotene as an anti-cancer and tocopherol as a source of vitamin E3. In addition, palm oil can be a non-cholesterol cooking oil (low cholesterol levels) and contains fatty acids, which are the main components of fats consisting of saturated and unsaturated fatty acids [2,3]. The main components of saturated fatty acids in palm cooking oil are palmitic acid (C-16), oleic acid (C-18: monounsaturated), and linoleic acid (C-18: polyunsaturated), while the other components are in amounts, few are myristic acid (C-14) and stearic acid (C-18) [4]. Palm oil has a fatty acid composition, which is different from other cooking oils because it contains a composition of saturated acids that is almost the

same as unsaturated fatty acids, namely 50% saturated fatty acids and 50% unsaturated fatty acids [5].

In the community, cooking oil is widely used in food processing because it can function as a medium for conveying heat, adding a savory taste, adding nutritional value and calories in food, texture, and appearance of food becomes more attractive, and dry surface [6,7]. In addition, cooking oil can also be used for various food processing processes and is used in almost all types of food preparation such as frying, sautéing, grilling, baking, curling, rolling, and cooking by means of extrusion [8]. Frying is one way to cook raw food into cooked food using cooking oil. Deep frying processing requires a large amount of cooking oil in order to submerge entirely of food ingredients in cooking oil [5]. This condition encourages to use cooking oil repeatedly. The use of cooking oil the longer and repeatedly, the quality will decrease due to oxidation fatty acid. Cooking oil has been oxidized can cause poisoning and other negative effects on human health, but the tendency is that people still often use cooking oil repeatedly for economic purposes [9,10]. In addition to economic factors, it is also due to an increase in prices of basic necessities due to government policies to raise fuel prices, thus encouraging people both industry and households to use cooking oil repeatedly. In developing countries, there are still many repeated frying using cooking oil repeatedly with economic goals. Cooking oil has become an inseparable part of the modern food processing system so that its safety is very important for health institutions throughout the world to provide health insurance among the public in consuming cooking oil [11].

The quality of cooking oil is determined by its constituent fatty acid components, which are classes of saturated or unsaturated fatty acids. Saturated fatty acids have adverse effects on health; otherwise unsaturated fatty acids are a good source of nutrition for health. Saturated fatty acids have the potential to increase blood cholesterol, while unsaturated fatty acids can reduce blood cholesterol. In the cooking process, the chemical composition of cooking oil used has contained frying foodstuffs of unsaturated fatty acids and other byproducts that can reduce the quality of cooking oil so that it becomes toxic and often carcinogenic [12]. The composition of fatty acids in cooking oil changes physicochemical properties due to the thermal process during frying. The physicochemical properties of cooking oil used repeatedly changed at a frying temperature of 180°C and a frying time of 10 minutes by repeating the frying five times, namely the formation of trans fatty acids (chemical properties) and increased viscosity (physical properties) [13]. Some in vivo research results suggest that consumption of thermally oxidized cooking oil may be unhealthy because it can affect the lipid profile, namely an increase in low-density lipoprotein (LDL), a decrease in high-density lipoprotein (HDL) and an increase in cholesterol levels, a hematological system, white blood cell counts. (WBC), neutrophil and lymphocyte counts, obesity, coronary heart disease (CHD) and cardiovascular disease, increased blood pressure, atherosclerosis, kidney function, and can induce lipid peroxidation and oxidative stress that have been linked to the pathogenesis of various degenerative diseases [14,15]. Consumption of coconut oil produces LDL cholesterol, which is much higher than non-tropical oil [16].

Based on previous studies, the frying food with a deep frying method using a pan for 15 minutes. The results obtained are that the sample contains more unsaturated fatty acids than saturated, ie, palmitic acid is the main saturated fatty acid; oleic acid is the main unsaturated fatty acid with linoleic acid, linolenic acid, and palmitoleic acid in varying amounts [8]. Lim et al. has detected the falsification of fresh palm olein (FPO) with RCO using fatty acid compositions and Fourier-transform infrared (FTIR) spectral analysis combined with

chemometrics [17]. The FPO is added to the electric frying pan (DFT-6000) with a maximum capacity (5.5 L) and heated for about 20 minutes to reach a temperature of 180°C. The results show a tendency to decrease PUFAs, which is consistent with the increasing magnitude of changes in the level of counterfeiting, and this might be a good indicator to detect the occurrence of FPO forgery with RCO. Of the two results of this study, more specific testing of cooking oil without using additional elements.

Especially, the objective in this study is applied cooking oil with additional elements, namely turmeric extract obtained from the turmeric plant (*Curcuma longa*) as one of the sources of natural antioxidants that contain curcumin. Turmeric is a useful source of natural antioxidants agents and can provide significant protection against damage to cooking oil due to free radicals and can also prevent fat peroxidation [18,19]. Curcumin ($C_{21}H_{20}O_6$) in turmeric is an active component, hydrophobic yellow-orange polyphenols derived from turmeric rhizomes, and has been used in food as a stabilizer in jelly or as a natural dye in cheese and as an additive in traditional medicine [20–22]. According to Abriana and Johannes [23] showed that the addition of turmeric extract into cooking oil could reduce the formation of trans fatty acids and extend the time of use of cooking oil; and based on the results of the analysis of trans fatty acid levels, the best treatment is the addition of turmeric extract at a concentration of 0.03%. The objective to be achieved in this research is to compare the composition of fatty acids in cooking oil from repeated frying without added turmeric extract with cooking oil that has been added turmeric extract. The contribution of this research is more towards food safety and health for consuming fried food.

2. Materials and Methods

This study aims to test the composition of fatty acids in cooking oil from repeated frying using an experimental laboratory test with 2 (two) types of treatment, namely cooking oil from frying without adding turmeric extract and frying oil from frying with added turmeric extract with 10 repetitions of frying because it is suspected that repeated frying will increase the composition of fatty acids in cooking oil. The main focus of research is to uncover the phenomenon of cooking oil due to repeated frying by analyzing fatty acid levels using gas chromatography.

2.1. Preparation of turmeric extract.

The use of turmeric extract is a consideration of its function as an antioxidant so that it can inhibit thermal oxidation in cooking oil during frying because it contains curcumin, which is a yellow active component and can be extracted from turmeric rhizome. Turmeric is first selected and cleaned, then cut into small pieces or thinly. Then the turmeric is weighed as much as 100 grams for preparation of extraction. 100 grams of turmeric is dried in an oven at 100°C for 1 hour. After drying, then put into a three-neck flask plus 98% glacial acetic acid solvent that has been diluted with a ratio of 1:1 with a total volume of 300 mL solvent. The heater is turned on, and the return cooler is activated. The zero time of extraction is determined when glacial acetic acid reaches its boiling point (118.1°C) and ends at the specified time for 75 minutes. The extraction results are cooled and filtered using filter paper. The filtrate is distilled while the residue is removed. The filtrate obtained from the extraction was put into a distillation flask to separate the turmeric extract from the solvent. The heater is turned on, and the result is solvent and residue. The residue is dried in an oven at 120°C to remove the residual glacial acetic acid

that is still present in turmeric extract. After that, weighing is done until a constant weight is obtained. Turmeric extract was added to cooking oil before frying food with a concentration of 0.03% [23].

2.2. Frying of food Test.

Food frying is done using the deep frying method by using an electric frying kettle equipped with a temperature and time regulator. The frying process starts by putting fresh cooking oil into the frying boiler as much as 3.5 liters (maximum capacity), then the kettle is heated to a temperature of 180°C. Food is fried until cooked within 10 minutes and made as little as possible stirring to reduce the flow of convection in oil and oxidation reactions due to the aeration process. The analysis was carried out on fresh oil (oil that has not been used for frying foodstuffs) as control and on two oil samples, namely cooking oil from frying without added turmeric extract and cooking oil from frying with added turmeric extract. The oil used for repeating the frying is the same oil (it is not replaced, and no additional volume of fresh oil is made). Frying is repeated 10 times with the same temperature and time of frying. Cooking oil samples were taken immediately after the frying process as much as 200 mL, then the oil in the kettle was allowed to cool down and continued with the next frying which is frying first, second, third, fourth, fifth, sixth, seventh, eighth, ninth and tenth [23]. Samples taken for analysis of fatty acid content are samples from the repetition of the first, fifth, and tenth frying.

2.3. Characterization of Cooking Oil.

First, the cooking oil is hydrolyzed into fatty acids, then transformed into a more volatile ester form. The transformation is carried out by methylation to obtain fatty acid methyl esters (FAME); Furthermore, this FAME was analyzed with GC-2010 (Gas Chromatograph) Plus Serial No. gas chromatography. C11804700336 Shimadzu Corp., using standard methods from The Association of Official Analytical Chemists (AOAC). The analysis starts by injecting of solvent as much as 1.0 μL into the column to obtain a baseline. If the carrier gas flow and heating system are perfect, the peak of the solvent will appear in less than 1 minute. After obtaining the baseline, then proceed by injecting 1 μL of the standard FAME mixture (Supelco TM 37 Component FAME Mix Catalog No. 47885-U, Bellefonte, PA, USA). When all the peaks are out, the prepared sample is injected as much as 1.0 μL. Retention times and peak samples were measured for each component.

3. Results and Discussion

In this study, we produced the component of saturated fatty acids in cooking oil namely lauric acid (C12:0), myristic acid (C14:0), palmitic acid (C16:0), and stearic acid (C18:0) while acids Unsaturated fats such as elaidic acid (C18:1n9t), oleic acid (C18:1n9c), linoleic acid (C18:2n6c), cis-11-eicosenoic acid (C20:1), linolenic acid (C18:3n3), linoleic acid (C18:2n6c), cis-11-eicosenoic acid (C20:1), linolenic acid (C18:3n3), and cis-11,14-eicosadienoic acid (C20:2). The highest saturated fatty acid content in fresh cooking oil (as control) is palmitic acid (C16:0) meanwhile, unsaturated fatty acid is oleic acid (C18:1n9c). The higher content of palmitic acid (C16:0) in cooking oil is the major component of palmitic acid in palm oil [11]. The HPLC analysis has exhibited that cooking oil based on palm oil contains the high saturated fatty acid like palmitic acid 30.88% and unsaturated fatty acids namely oleic acid 35.86%, linoleic acid 10.41%, stearic acid 3.43%, mistic acid 0.76%; lauric acid 0.18%; linolenic acid

0.18%; cis-11-eicosenoic acid 0.14%; elaidic acid 0.09% and cis-11,14-eicosadienoic acid 0.07% (Table 1).

Table 1. Composition of fatty Acids from recycled frying cooking oil.

Treatment	Fatty Acids	Frying Treatment (time) [%]				Standards based on O'Brien (2003) [24]
		0	1	5	10	
Untreated Cooking Oil	**Saturated Fatty Acids**					
	Lauric Acid, C12:0	0.18 ±0.003	0.18 ±0.010	0.19 ±0.015	0.19 ±0.015	0.1-1.0
	Myristic Acid, C14:0	0.76 ±0.010	0.89 ±0.012	0.86 ±0.036	0.82 ±0.017	0.9-1.5
	Palmitic Acid, C16:0	30.88 ±0.080	34.83 ±0.555	34.00 ±1.167	32.90 ±1.795	41.8-46.8
	Stearic Acid, C18:0	3.43 ±0.035	3.75 ±0.115	3.73 ±0.075	3.68 ±0.367	4.5-5.1
	Unsaturated Fatty Acids					
	Elaidic Acid, C18:1n9t	0.09 ±0.010	0.09 ±0.006	0.11 ±0.001	0.11 ±0.001	<1
	Oleic Acid, C18:1n9c	35.86 ±0.145	40.47 ±0.746	40.18 ±0.812	38.52 ±2.807	37.3-40.8
	Linoleic Acid, C18:2n6c	10.41 ±0.02	11.56 ±0.165	11.41 ±0.214	10.61 ±0.735	9.1-11.0
	Cis-11-Eicosenoic Acid, C20:1	0.14 ±0.006	0.13 ±0.006	0.13 ±0.006	0.13 ±0.015	-
	Linolenic Acid, C18:3n3	0.18 ±0.005	0.20 ±0.010	0.19 ±0.003	0.17 ±0.006	<1.5
	Cis-11,14-Eicosedienoic Acid, C20:2	0.07 ±0.001	0.09 ±0.021	0.10 ±0.017	0.09 ±0.015	-
Cooking Oil + 0.03% Turmeric	**Saturated Fatty Acids**					
	Lauric Acid, C12:0	0.14 ±0.001	0.10 ±0.006	0.11 ±0.006	0.11 ±0.012	0.1-1.0
	Myristic Acid, C14:0	0.77 ±0.010	0.75 ±0.016	0.73 ±0.021	0.81 ±0.051	0.9-1.5
	Palmitic Acid, C16:0	28.5 ±0.580	29.49 ±0.640	29.25 ±0.957	28.75 ±3.788	41.8-46.8
	Stearic Acid, C18:0	2.96 ±0.050	3.44 ±0.081	3.47 ±0.090	3.61 ±0.182	4.5-5.1
	Unsaturated Fatty Acids					
	Elaidic Acid, C18:1n9t	0.07 ±0.001	0.09 ±0.006	0.09 ±0.006	0.09 ±0.006	<1
	Oleic Acid, C18:1n9c	32.97 ±0.560	33.24 ±1.025	34.05 ±1.100	35.43 ±1.974	37.3-40.8
	Linoleic Acid, C18:2n6c	8.89 ±0.160	9.74 ±0.211	9.94 ±0.495	10.19 ±0.560	9.1-11.0
	Cis-11-Eicosenoic Acid, C20:1	0.14 ±0.006	0.11 ±0.006	0.12 ±0.001	0.12 ±0.006	-
	Linolenic Acid, C18:3n3	0.18 ±0.003	0.18 ±0.015	0.18 ±0.017	0.18 ±0.012	<1.5
	Cis-11,14-Eicosedienoic Acid, C20:2	0.06 ±0.001	0.05 ±0.010	0.04 ±0.010	0.06 ±0.010	-

In addition, we added the turmeric extract 0.03% into cooking oil to suppress oxidation reaction shows that the high saturated fatty acid such as palmitic acid 28.5% and unsaturated fatty acids content of oleic acid 32.97%, linoleic acid 8.89%, stearic acid 2.96%, myristic acid 0.77%, linolenic acid 0.18%; lauric acid 0.14%, cis-11-eicosenoic acid 0.14%; elaidic acid 0.07% and cis-11,14-eicosadienoic acid 0.06% (Table 1). The composition of most fatty acids in recycled cooking oil (RCO) is in the range according to Codex standards, except for C8:0, C10:0, C11:0, C11:0, trans C18:1, and polyunsaturated fatty acids (PUFAs), C20:5 [17]. According to Awogbemi [25] reported that palm oil contained 87.7% unsaturated fatty acids and 12.3% saturated fatty acids. Based on these results also show the variation of cooking oil used and type of food fried greatly affect the properties and composition of fatty acids. Overall, in fresh cooking oil was contained 63.16% linoleic acid 20.72%, linolenic acid 10.53%, stearic acid 5.26%, and the smallest component was palmitic acid 0.33% [26].

3.1. Saturated fatty acids.

The saturated fatty acid has been investigated into repeated frying cooking oil based on palm oil; we found the lauric acid, myristic acid, palmitic acid, and stearic acid compounds. Certainly, palm oil as feedstock to produce cooking oil contains 92% saturated fatty acids, including 48% lauric acid, myristic acid 20%, and palmitic acid 9%, with monounsaturated fatty acids 6% and polyunsaturated fatty acids 1.7% [27]. Figure 1 extracted from Table 1 to observe the range composition and an upward or downward trend in each composition of organic constituents in cooking oil. Figure 1 was recurring frying oil without added turmeric extract showed that before fried the lauric acid of 0.18% (0 times), first frying 0.18% (1 time), fifth frying 0.19% (5 times) and tenth frying 0.19% (10 times). We also compare each organic constituents in cooking oil with results that have been studied from O'Brien and Richard D. [24] as standard organic constituents in fats and oils. Based on frying treatment, the lauric acid frequency looks to increase; it means that the repetition of a frying treatment can increase the lauric acid compound. Then it is compared with standard 0.1-1.0 shows that do not exceed the specified standard.

Meanwhile, the cooking oil has been added turmeric extract 0.03% contains lauric acid of 0.14% (0 times), 0.10% (1 time), 0.11% (5 times) and 0.11% (10 times). The lauric acid frequency was decreased in the first frying, then increase in the fifth and tenth frying (+0.01). By adding 0.03% turmeric extract can reduce the lauric acid compound, then it is compared with a standard data where it does not exceed the predetermined. The lauric acid is also mostly found in virgin coconut oil (VCO), which consists of 90% medium-chain fatty acids (dominated by lauric acid, which is 45-55% and 10% long-chain fatty acids). If it is compared with oil palm, VCO has a higher of lauric acid content, which is 54.06%, meanwhile in palm oil of 0.10%. Lauric acid plays a role in maintaining health, among others, functions to kill various types of microbes derived from fatty acids, to increase metabolic activity, and protect the body from disease and accelerate healing [28]. Among saturated fatty acids, lauric acid has been shown to contribute the least to fat accumulation [29]. Likewise, myristic acid has not exceeded the predetermined standard. Myristic acid (C14:0) is a fatty acid that is found in palm kernel oil and coconut oil, which can increase low-density lipoprotein (LDL) cholesterol levels, but it is a minor group in food. It is a long-chain saturated fatty acid (14:0) and also one of the fattiest acids found in milk fat (above 10%) [30].

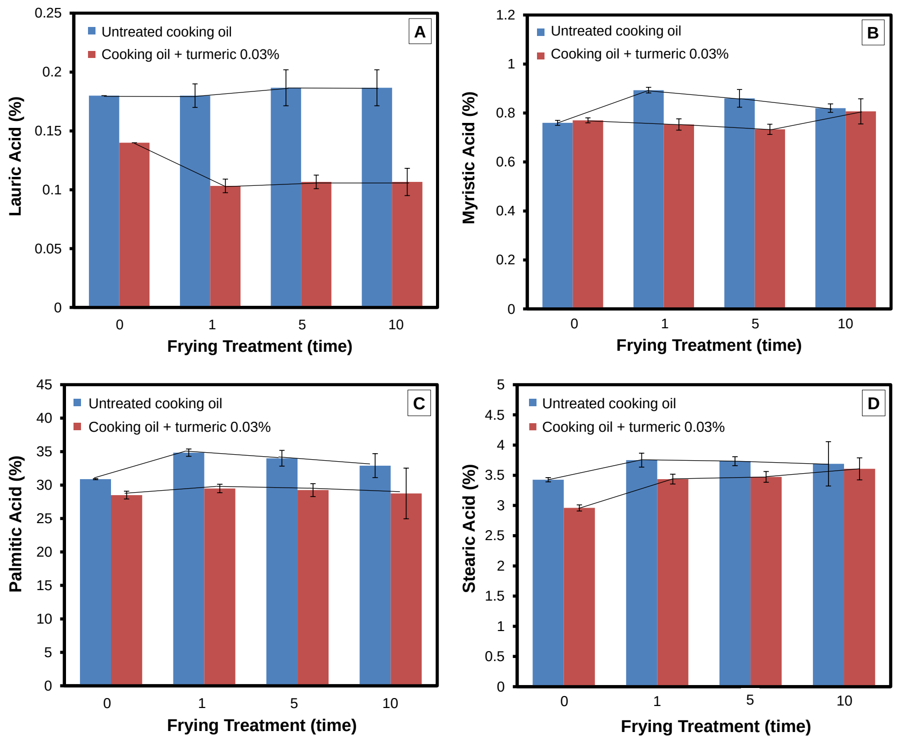


Figure 1. Saturated fatty acids component, (A) Lauric acid, (B) Myristic acid, (C) Palmitic acid and (D) Stearic acid.

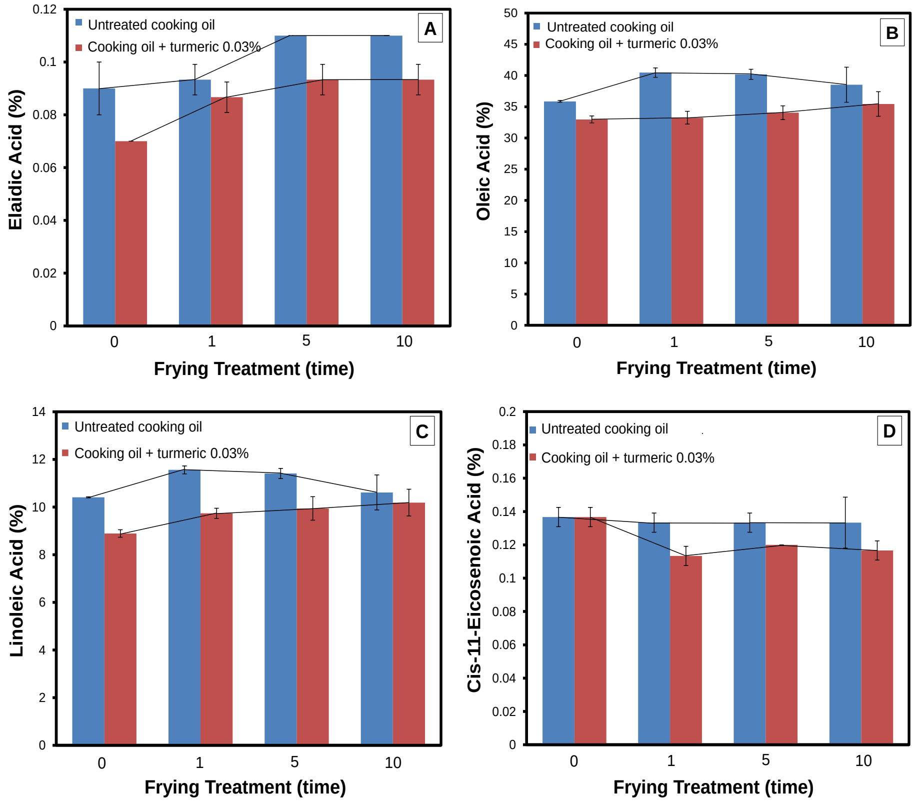
Figure 1C the palmitic acid was quite increased along with the repetition of the frying, and it's still lower than the standard which has been specified (41.8-46.8). Palmitic acid is the main fatty acid in palm oil [31]. Palmitic acid is also the main component of saturated fatty acids in food, which contains vegetable oils 6-10% and can increase LDL cholesterol levels. The presence of palmitic acid in cooking oil can be used as an indicator to detect falsification of fresh palm oil (FPO) with RCO using fatty acid composition analysis (FAC) [17]. Figure 1D also exhibited of the stearic acid compound can be seen that has increased along with the repetition of the frying and compared with a standard in a range of 4.5-5.1 where the saturated fatty acid of stearic acid is still lower from predetermined standards. It is a major component of various types of fat with different amounts, such as animal fat (beef fat) containing 15-20% and only a little in vegetable oil, 4-5% [31]. Stearic acid lowers LDL and HDL cholesterol concentrations when compared with palmitic acid because these fatty acids are quickly converted to monounsaturated fatty acids and oleic acid interesterification of fats rich in palmitic acid or stearic acid does not appear to affect serum lipid fasting and (apo) lipoprotein [32].

Based on saturated fatty acid results and compared with standard fats and oils, we discover that the oil from repeated frying produces saturated fatty acids that do not exceed the specified standard. This means that repeated frying oil based on palm oil is still safe for consumption because of all the saturated fatty acids found within the reasonable standard range, though that can raise cholesterol levels (myristic acid and palmitic acid). In vegetable oils such as palm oil is dominated by more carbon atoms, whereas in animal oils are odd carbon atoms and contain more polyunsaturated fatty acids (PUFA) [33]. Cooking oil with high saturated fatty acid content will affect the stability of food items that are fried during frying [34,35]. In addition, the high content of fatty acids causes oil to be easily damaged during cooking processing because the oil will be heated continuously at high temperatures and direct contact with oxygen in the surrounding air, which facilitates the oxidation reaction to the oil. According to Baba-Moussa et al. [12], an increase in temperature followed by a long heating time indicates that an increase in the fatty acid component forms triglycerides. The result of triglyceride hydrolysis will produce saturated and unsaturated fatty acids based on the presence or absence of carbon chain double bonds in the molecule.

3.2. Unsaturated fatty acids.

The presence of organic constituents in repeated frying oil has been examined that it contains elaidic acid, oleic acid, linoleic acid, cis-11-eicosenoic acid, linolenic acid, and cis-11,14-eicosadienoic acid. Based on Figure 2A the content of untreated cooking oil from elaidic acid showed that 0.09% (0 times), 0.09% (1 time), 0.11% (5 times) and 0.11% (10 times), while the frying oil added 0.03% turmeric extract showed the treatment before frying 0.07% (0 times), 0.09% (1 time), 0.09% (5 times) and 0.09% (10 times). If seen from the frequency of elaidic acid (Figure 2A) that repeated frying can increase the level of elaidic acid and compare with standard <1 that it does not exceed the specified standard. This is because trans fatty acids (TFA) in elaidic acid are unsaturated fatty acids with at least one double bond in the form of trans configuration that can occur naturally from ruminants-based meat and dairy products, or artificially through partial hydrogenation of vegetable oils in industry food processing [36]. Sartika also reported that trans fatty acids (elaidate) were only formed after the second repetition of deep-frying, and their levels increased with the repeated use of oil. Based on the initial formation of trans fatty acids, the frying process should be done on medium heat (<200°C), and the cooking oil used should not exceed 2 (two) repetitions. Not so in the oleic acid compound (Figure 2B) shows a tendency to vary, if it is compared with the standard of 37.3-40.8. Whereas the recycled frying oil added with 0.03% turmeric extract showed an increase along with the repetition of the frying and when compared with the standard 37.3-40.8. These results indicate that oleic acid is still lower than the standard value.

Furthermore, the content of linoleic acid (Figure 2C) in untreated cooking oil showed the same conditions varying when compared with the standard of 9.1-11.0. One that met the standard was the treatment before the tenth frying and frying, while those that do not meet the standards in the first and fifth frying treatment. Then, it compared with frying cooking oil added 0.03% turmeric extract showed an increase along with the repetition of the frying and compared with the standard the first, fifth, and tenth frying have met the standards. Meanwhile, which did not meet the standards in the treatment before the addition of turmeric extract such as the first and fifth frying. This result showed that repeated frying could increase the levels of linoleic acid in the oil from repeated frying by adding 0.03% turmeric extract. It is due to the conjugation of linolenic acid isomer refers to a group of positions and geometrical isomers of omega-3-α-linolenic acid essential acids (cis-9, cis-12, cis-15 C18: 3; ALA) [37,38].



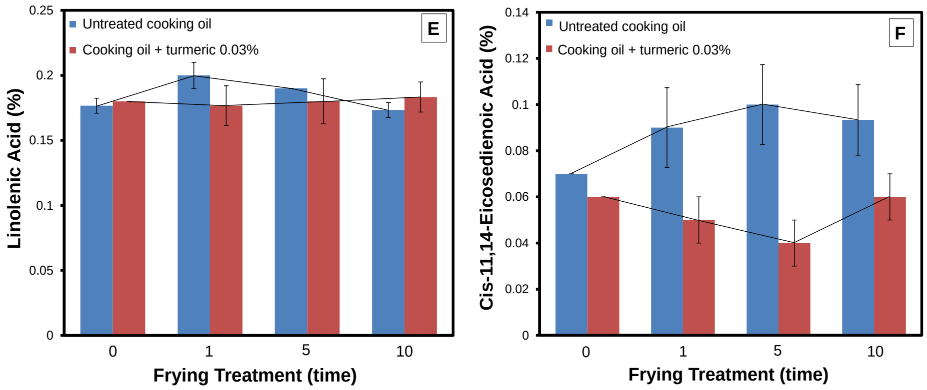


Figure 2. Unsaturated fatty acids component (A) elaidic acid, (B) oleic acid, (C) linoleic acid, (D) cis-11-eicosenoic acid, (E) linolenic acid, and (F) cis-11,14-eicosadienoic acid.

The content of cis-11-eicosenoic acid (Figure 2D) in untreated cooking oil and added 0.03% turmeric extract had decreased levels caused by slow oxidation reactions against cis-11-eicosenoic acid. The frequency of linolenic acid (Figure 2E) in unprocessed cooking oil shows a variable trend. At the beginning of the frying (1 time), there was an increase compared to those not treated, but over time the frying duration decreases. In otherwise, by adding turmeric extract shows a quite static level before frying to the tenth repetition treatment. It shows that turmeric extract can suppress the occurrence oxidation reaction. Meanwhile, Figure 2F depicts cis-11-14-eicosadienoic acid has increased in untreated cooking oil, while the unique by adding turmeric extract dramatically decrease levels. It is concluded cooking oil without treatment has shown increase unsaturated acid levels. The performance of turmeric extract has quite demonstrated efficiency in suppressing chemical reactions during frying treatment [39]. In addition, turmeric extract can function as an antioxidant so that it can inhibit thermal oxidation in cooking oil during repeated frying. This will affect the composition of fatty acids contained in cooking oil. According to Kim and Clifton [40] showed that curcumin (diferuloylmethane) is the main secondary metabolite in turmeric extract, which is beneficial to the human body as antioxidant and anti-inflammatory properties. Curcumin, as a bioactive component, has been shown to be a broad biological action. To date, it has been reported that natural colored extracts are isolated from turmeric by various methods such as maceration, digestion, microwave, and infusion [21]. Turmeric varieties studied by Tanvir et al. [18] is a useful source of natural antioxidants and can provide protection against free radical damage. Curcumin can be used as a food additive and is also good for use as conventional medicine [41].

4. Conclusions

This study reports the chemical composition of cooking oil consisting of saturated fatty acids, such as lauric acid, myristic acid, palmitic acid, and stearic acid. Whereas, the unsaturated fatty acids of elaidic acid, oleic acid, linoleic acid, cis-11-eicosedienoic acid, linolenic acid, and cis-11,14-eicosedienoic acid. The highest saturated fatty acid levels in cooking oil before frying, are palmitic acid of 30.88%, whereas unsaturated fatty acids, namely oleic acid of 35.86%. The high saturated fatty acid content in oil cooking before the frying process is palmitic acid of 30.88%, whereas the unsaturated fatty acid is oleic acid of 32.97%. Turmeric extract added to cooking oil can function as an anticosidan so that it can inhibit thermal oxidation in cooking oil during repeated frying. The treatment of repeated frying affects the fatty acids contained in repeated cooking oils, both saturated fatty acids and unsaturated fatty acids.

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Conflicts of Interest

The authors declare no conflict of interest.

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Identification of Organic Constituents in Cooking Oil by Adding Turmeric as a Potential Antioxidant Agent

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Abstract: The objective of this study to compare the fatty acids composition in cooking oil from repeated frying without added turmeric extract and added. The research design is testing the composition of fatty acids in repeated cooking oil using two types of treatment, namely cooking oil from frying without adding turmeric extract and cooking oil from frying with 0.03% turmeric extract added with 10 times frying repeat because it is suspected that repeated frying will increase the composition of fatty acids in cooking oil. The analysis of fatty acids was conducted using gas chromatography. Based on these results that the fatty acid components were produced of saturated fatty acids, namely lauric acid, myristic acid, palmitic acid, and stearic acid, whereas unsaturated fatty acids also detected such as elaidic acid, oleic acid, linoleic acid, cis-11-eicosadienoic acid, linolenic acid, and cis-11,14-eicosadienoic acid. The highest saturated fatty acid content in cooking oil before frying is palmitic acid (30.88%), whereas unsaturated fatty acid was oleic acid (35.86%). The highest content of saturated fatty acids in cooking oil has been added turmeric extract before frying is palmitic acid (28.5%), while unsaturated fatty acid of oleic acid was 32.97%.

Keywords: cooking oil; fatty acid; curcumin; chemical; content.

1. Introduction

Cooking oil is one of the foodstuffs consumed by the majority of Indonesia's population with consumption levels reaching more than 2.5 million tons per year, or more than 12 kg/person/year, and also the dominant foodstuffs used by the community to process of feedstock into food made from palm oil [1]. As a food ingredient, palm oil has several advantages over other cooking oils, which contain carotene as an anti-cancer and tocopherol as a source of vitamin E3. In addition, palm oil can be a non-cholesterol cooking oil (low cholesterol levels) and contains fatty acids, which are the main components of fats consisting of saturated and unsaturated fatty acids [2,3]. The main components of saturated fatty acids in palm cooking oil are palmitic acid (C-16), oleic acid (C-18: monounsaturated), and linoleic acid (C-18: polyunsaturated), while the other components are in amounts, few are myristic acid (C-14) and stearic acid (C-18) [4]. Palm oil has a fatty acid composition, which is different from other cooking oils because it contains a composition of saturated acids that is almost the

same as unsaturated fatty acids, namely 50% saturated fatty acids and 50% unsaturated fatty acids [5].

In the community, cooking oil is widely used in food processing because it can function as a medium for conveying heat, adding a savory taste, adding nutritional value and calories in food, texture, and appearance of food becomes more attractive, and dry surface [6,7]. In addition, cooking oil can also be used for various food processing processes and is used in almost all types of food preparation such as frying, sautéing, grilling, baking, curling, rolling, and cooking by means of extrusion [8]. Frying is one way to cook raw food into cooked food using cooking oil. Deep frying processing requires a large amount of cooking oil in order to submerge entirely of food ingredients in cooking oil [5]. This condition encourages to use cooking oil repeatedly. The use of cooking oil the longer and repeatedly, the quality will decrease due to oxidation fatty acid. Cooking oil has been oxidized can cause poisoning and other negative effects on human health, but the tendency is that people still often use cooking oil repeatedly for economic purposes [9,10]. In addition to economic factors, it is also due to an increase in prices of basic necessities due to government policies to raise fuel prices, thus encouraging people both industry and households to use cooking oil repeatedly. In developing countries, there are still many repeated frying using cooking oil repeatedly with economic goals. Cooking oil has become an inseparable part of the modern food processing system so that its safety is very important for health institutions throughout the world to provide health insurance among the public in consuming cooking oil [11].

The quality of cooking oil is determined by its constituent fatty acid components, which are classes of saturated or unsaturated fatty acids. Saturated fatty acids have adverse effects on health; otherwise, unsaturated fatty acids are a good source of nutrition for health. Saturated fatty acids have the potential to increase blood cholesterol, while unsaturated fatty acids can reduce blood cholesterol. In the cooking process, the chemical composition of cooking oil used has contained frying foodstuffs of unsaturated fatty acids and other byproducts that can reduce the quality of cooking oil so that it becomes toxic and often carcinogenic [12]. The composition of fatty acids in cooking oil changes physicochemical properties due to the thermal process during frying. The physicochemical properties of cooking oil used repeatedly changed at a frying temperature of 180°C and a frying time of 10 minutes by repeating the frying five times, namely the formation of trans fatty acids (chemical properties) and increased viscosity (physical properties) [13]. Some in vivo research results suggest that consumption of thermally oxidized cooking oil may be unhealthy because it can affect the lipid profile, namely an increase in low-density lipoprotein (LDL), a decrease in high-density lipoprotein (HDL) and an increase in cholesterol levels, a hematological system, white blood cell counts. (WBC), neutrophil and lymphocyte counts, obesity, coronary heart disease (CHD) and cardiovascular disease, increased blood pressure, atherosclerosis, kidney function, and can induce lipid peroxidation and oxidative stress that have been linked to the pathogenesis of various degenerative diseases [14,15]. Consumption of coconut oil produces LDL cholesterol, which is much higher than non-tropical oil [16].

Based on previous studies, the frying food with a deep frying method using a pan for 15 minutes. The results obtained are that the sample contains more unsaturated fatty acids than saturated, i.e., palmitic acid is the main saturated fatty acid; oleic acid is the main unsaturated fatty acid with linoleic acid, linolenic acid, and palmitoleic acid in varying amounts [8]. Lim *et al*. has detected the falsification of fresh palm olein (FPO) with RCO using fatty acid compositions and Fourier-transform infrared (FTIR) spectral analysis combined with

chemometrics [17]. The FPO is added to the electric frying pan (DFT-6000) with a maximum capacity (5.5 L) and heated for about 20 minutes to reach a temperature of 180°C. The results show a tendency to decrease PUFAs, which is consistent with the increasing magnitude of changes in the level of counterfeiting, and this might be a good indicator to detect the occurrence of FPO forgery with RCO. Of the two results of this study, more specific testing of cooking oil without using additional elements.

Especially, the objective in this study is applied cooking oil with additional elements, namely turmeric extract obtained from the turmeric plant (*Curcuma longa*) as one of the sources of natural antioxidants that contain curcumin. Turmeric is a useful source of natural antioxidants agents and can provide significant protection against damage to cooking oil due to free radicals and can also prevent fat peroxidation [18,19]. Curcumin ($C_{21}H_{20}O_6$) in turmeric is an active component, hydrophobic yellow-orange polyphenols derived from turmeric rhizomes, and has been used in food as a stabilizer in jelly or as a natural dye in cheese and as an additive in traditional medicine [20–22]. According to Abriana and Johannes [23] showed that the addition of turmeric extract into cooking oil could reduce the formation of trans fatty acids and extend the time of use of cooking oil; and based on the results of the analysis of trans fatty acid levels, the best treatment is the addition of turmeric extract at a concentration of 0.03%. The objective to be achieved in this research is to compare the composition of fatty acids in cooking oil from repeated frying without added turmeric extract with cooking oil that has been added turmeric extract. The contribution of this research is more towards food safety and health for consuming fried food.

2. Materials and Methods

This study aims to test the composition of fatty acids in cooking oil from repeated frying using an experimental laboratory test with 2 (two) types of treatment, namely cooking oil from frying without adding turmeric extract and frying oil from frying with added turmeric extract with 10 repetitions of frying because it is suspected that repeated frying will increase the composition of fatty acids in cooking oil. The main focus of research is to uncover the phenomenon of cooking oil due to repeated frying by analyzing fatty acid levels using gas chromatography.

2.1. Preparation of turmeric extract.

The use of turmeric extract is a consideration of its function as an antioxidant so that it can inhibit thermal oxidation in cooking oil during frying because it contains curcumin, which is a yellow active component and can be extracted from turmeric rhizome. Turmeric is first selected and cleaned, then cut into small pieces or thinly. Then the turmeric is weighed as much as 100 grams for preparation of extraction. 100 grams of turmeric is dried in an oven at 100°C for 1 hour. After drying, then put into a three-neck flask plus 98% glacial acetic acid solvent that has been diluted with a ratio of 1:1 with a total volume of 300 mL solvent. The heater is turned on, and the return cooler is activated. The zero time of extraction is determined when glacial acetic acid reaches its boiling point (118.1°C) and ends at the specified time for 75 minutes. The extraction results are cooled and filtered using filter paper. The filtrate is distilled while the residue is removed. The filtrate obtained from the extraction was put into a distillation flask to separate the turmeric extract from the solvent. The heater is turned on, and the result is solvent and residue. The residue is dried in an oven at 120°C to remove the residual glacial acetic acid

that is still present in turmeric extract. After that, weighing is done until a constant weight is obtained. Turmeric extract was added to cooking oil before frying food with a concentration of 0.03% [23].

2.2. Frying of food test.

Food frying is done using the deep frying method by using an electric frying kettle equipped with a temperature and time regulator. The frying process starts by putting fresh cooking oil into the frying boiler as much as 3.5 liters (maximum capacity), then the kettle is heated to a temperature of 180°C. Food is fried until cooked within 10 minutes and made as little as possible stirring to reduce the flow of convection in oil and oxidation reactions due to the aeration process. The analysis was carried out on fresh oil (oil that has not been used for frying foodstuffs) as control and on two oil samples, namely cooking oil from frying without added turmeric extract and cooking oil from frying with added turmeric extract. The oil used for repeating the frying is the same oil (it is not replaced, and no additional volume of fresh oil is made). Frying is repeated 10 times with the same temperature and time of frying. Cooking oil samples were taken immediately after the frying process as much as 200 mL, then the oil in the kettle was allowed to cool down and continued with the next frying which is frying first, second, third, fourth, fifth, sixth, seventh, eighth, ninth and tenth [23]. Samples taken for analysis of fatty acid content are samples from the repetition of the first, fifth, and tenth frying.

2.3. Characterization of cooking oil.

First, the cooking oil is hydrolyzed into fatty acids, then transformed into a more volatile ester form. The transformation is carried out by methylation to obtain fatty acid methyl esters (FAME); Furthermore, this FAME was analyzed with GC-2010 (Gas Chromatograph) Plus Serial No. gas chromatography. C11804700336 Shimadzu Corp., using standard methods from The Association of Official Analytical Chemists (AOAC). The analysis starts by injecting of solvent as much as 1.0 μL into the column to obtain a baseline. If the carrier gas flow and heating system are perfect, the peak of the solvent will appear in less than 1 minute. After obtaining the baseline, then proceed by injecting 1 μL of the standard FAME mixture (Supelco TM 37 Component FAME Mix Catalog No. 47885-U, Bellefonte, PA, USA). When all the peaks are out, the prepared sample is injected as much as 1.0 μL. Retention times and peak samples were measured for each component.

3. Results and Discussion

In this study, we produced the component of saturated fatty acids in cooking oil namely lauric acid (C12:0), myristic acid (C14:0), palmitic acid (C16:0), and stearic acid (C18:0) while acids Unsaturated fats such as elaidic acid (C18:1n9t), oleic acid (C18:1n9c), linoleic acid (C18:2n6c), cis-11-eicosenoic acid (C20:1), linolenic acid (C18:3n3), linoleic acid (C18:2n6c), cis-11-eicosenoic acid (C20:1), linolenic acid (C18:3n3), and cis-11,14-eicosadienoic acid (C20:2). The highest saturated fatty acid content in fresh cooking oil (as control) is palmitic acid (C16:0); meanwhile, an unsaturated fatty acid is an oleic acid (C18:1n9c). The higher content of palmitic acid (C16:0) in cooking oil is the major component of palmitic acid in palm oil [11]. The HPLC analysis has exhibited that cooking oil based on palm oil contains the high saturated fatty acid like palmitic acid 30.88% and unsaturated fatty acids namely oleic acid 35.86%, linoleic acid 10.41%, stearic acid 3.43%, mistic acid 0.76%; lauric acid 0.18%;

linolenic acid 0.18%; cis-11-eicosenoic acid 0.14%; elaidic acid 0.09% and cis-11,14-eicosadienoic acid 0.07% (Table 1).

Table 1. Composition of fatty Acids from recycled frying cooking oil.

Treatment	Fatty Acids	Frying Treatment (time) [%]				Standards-based on O'Brien (2003) [24]
		0	1	5	10	
Untreated Cooking Oil	**Saturated Fatty Acids**					
	Lauric Acid, C12:0	0.18 ±0.003	0.18 ±0.010	0.19 ±0.015	0.19 ±0.015	0.1-1.0
	Myristic Acid, C14:0	0.76 ±0.010	0.89 ±0.012	0.86 ±0.036	0.82 ±0.017	0.9-1.5
	Palmitic Acid, C16:0	30.88 ±0.080	34.83 ±0.555	34.00 ±1.167	32.90 ±1.795	41.8-46.8
	Stearic Acid, C18:0	3.43 ±0.035	3.75 ±0.115	3.73 ±0.075	3.68 ±0.367	4.5-5.1
	Unsaturated Fatty Acids					
	Elaidic Acid, C18:1n9t	0.09 ±0.010	0.09 ±0.006	0.11 ±0.001	0.11 ±0.001	<1
	Oleic Acid, C18:1n9c	35.86 ±0.145	40.47 ±0.746	40.18 ±0.812	38.52 ±2.807	37.3-40.8
	Linoleic Acid, C18:2n6c	10.41 ±0.02	11.56 ±0.165	11.41 ±0.214	10.61 ±0.735	9.1-11.0
	Cis-11-Eicosenoic Acid, C20:1	0.14 ±0.006	0.13 ±0.006	0.13 ±0.006	0.13 ±0.015	-
	Linolenic Acid, C18:3n3	0.18 ±0.005	0.20 ±0.010	0.19 ±0.003	0.17 ±0.006	<1.5
	Cis-11,14-Eicosedienoic Acid, C20:2	0.07 ±0.001	0.09 ±0.021	0.10 ±0.017	0.09 ±0.015	-
Cooking Oil + 0.03% Turmeric	**Saturated Fatty Acids**					
	Lauric Acid, C12:0	0.14 ±0.001	0.10 ±0.006	0.11 ±0.006	0.11 ±0.012	0.1-1.0
	Myristic Acid, C14:0	0.77 ±0.010	0.75 ±0.016	0.73 ±0.021	0.81 ±0.051	0.9-1.5
	Palmitic Acid, C16:0	28.5 ±0.580	29.49 ±0.640	29.25 ±0.957	28.75 ±3.788	41.8-46.8
	Stearic Acid, C18:0	2.96 ±0.050	3.44 ±0.081	3.47 ±0.090	3.61 ±0.182	4.5-5.1
	Unsaturated Fatty Acids					
	Elaidic Acid, C18:1n9t	0.07 ±0.001	0.09 ±0.006	0.09 ±0.006	0.09 ±0.006	<1
	Oleic Acid, C18:1n9c	32.97 ±0.560	33.24 ±1.025	34.05 ±1.100	35.43 ±1.974	37.3-40.8
	Linoleic Acid, C18:2n6c	8.89 ±0.160	9.74 ±0.211	9.94 ±0.495	10.19 ±0.560	9.1-11.0
	Cis-11-Eicosenoic Acid, C20:1	0.14 ±0.006	0.11 ±0.006	0.12 ±0.001	0.12 ±0.006	-
	Linolenic Acid, C18:3n3	0.18 ±0.003	0.18 ±0.015	0.18 ±0.017	0.18 ±0.012	<1.5
	Cis-11,14-Eicosedienoic Acid, C20:2	0.06 ±0.001	0.05 ±0.010	0.04 ±0.010	0.06 ±0.010	-

In addition, we added the turmeric extract 0.03% into cooking oil to suppress oxidation reaction shows that the high saturated fatty acid such as palmitic acid 28.5% and unsaturated fatty acids content of oleic acid 32.97%, linoleic acid 8.89%, stearic acid 2.96%, myristic acid 0.77%, linolenic acid 0.18%; lauric acid 0.14%, cis-11-eicosenoic acid 0.14%; elaidic acid 0.07% and cis-11,14-eicosadienoic acid 0.06% (Table 1). The composition of most fatty acids in recycled cooking oil (RCO) is in the range according to Codex standards, except for C8:0, C10:0, C11:0, C11:0, trans C18:1, and polyunsaturated fatty acids (PUFAs), C20:5 [17]. According to Awogbemi [25] reported that palm oil contained 87.7% unsaturated fatty acids and 12.3% saturated fatty acids. Based on these results also show the variation of cooking oil used and type of food fried greatly affect the properties and composition of fatty acids. Overall, in fresh cooking oil was contained 63.16% linoleic acid 20.72%, linolenic acid 10.53%, stearic acid 5.26%, and the smallest component was palmitic acid 0.33% [26].

3.1. Saturated fatty acids.

The saturated fatty acid has been investigated into repeated frying cooking oil based on palm oil; we found the lauric acid, myristic acid, palmitic acid, and stearic acid compounds. Certainly, palm oil as feedstock to produce cooking oil contains 92% saturated fatty acids, including 48% lauric acid, myristic acid 20%, and palmitic acid 9%, with monounsaturated fatty acids 6% and polyunsaturated fatty acids 1.7% [27]. Figure 1 extracted from Table 1 to observe the range composition and an upward or downward trend in each composition of organic constituents in cooking oil. Figure 1 was recurring frying oil without added turmeric extract showed that before fried the lauric acid of 0.18% (0 times), first frying 0.18% (1 time), fifth frying 0.19% (5 times) and tenth frying 0.19% (10 times). We also compare each organic constituents in cooking oil with results that have been studied from O'Brien and Richard D. [24] as standard organic constituents in fats and oils. Based on frying treatment, the lauric acid frequency looks to increase; it means that the repetition of a frying treatment can increase the lauric acid compound. Then it is compared with standard 0.1-1.0 shows that do not exceed the specified standard.

Meanwhile, the cooking oil has been added turmeric extract 0.03% contains lauric acid of 0.14% (0 times), 0.10% (1 time), 0.11% (5 times) and 0.11% (10 times). The lauric acid frequency was decreased in the first frying, then increase in the fifth and tenth frying (+0.01). By adding 0.03% turmeric extract can reduce the lauric acid compound, then it is compared with a standard data where it does not exceed the predetermined.

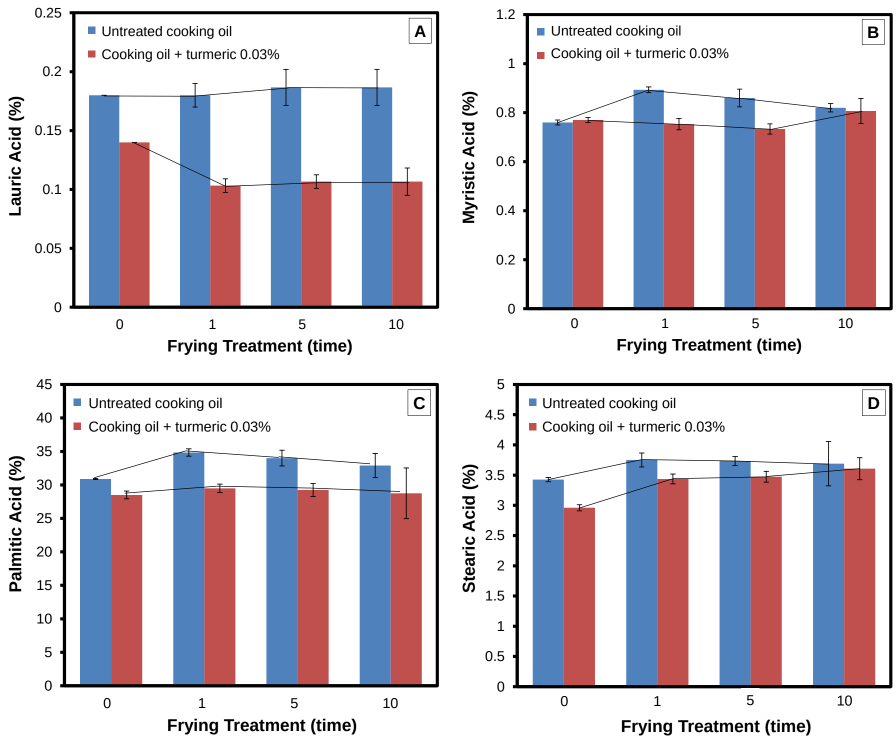

Figure 1. Saturated fatty acids component, (A) Lauric acid, (B) Myristic acid, (C) Palmitic acid and (D) Stearic acid.

The lauric acid is also mostly found in virgin coconut oil (VCO), which consists of 90% medium-chain fatty acids (dominated by lauric acid, which is 45-55% and 10% long-chain fatty acids). If it is compared with oil palm, VCO has a higher of lauric acid content, which is 54.06%, meanwhile in palm oil of 0.10%. Lauric acid plays a role in maintaining health, among others, functions to kill various types of microbes derived from fatty acids, to increase metabolic activity, and protect the body from disease and accelerate healing [28]. Among saturated fatty acids, lauric acid has been shown to contribute the least to fat accumulation [29]. Likewise, myristic acid has not exceeded the predetermined standard. Myristic acid (C14:0) is a fatty acid that is found in palm kernel oil and coconut oil, which can increase low-density lipoprotein (LDL) cholesterol levels, but it is a minor group in food. It is a long-chain saturated fatty acid (14:0) and also one of the fattiest acids found in milk fat (above 10%) [30].

Figure 1C the palmitic acid was quite increased along with the repetition of the frying, and it's still lower than the standard which has been specified (41.8-46.8). Palmitic acid is the main fatty acid in palm oil [31]. Palmitic acid is also the main component of saturated fatty acids in food, which contains vegetable oils 6-10% and can increase LDL cholesterol levels. The presence of palmitic acid in cooking oil can be used as an indicator to detect falsification of fresh palm oil (FPO) with RCO using fatty acid composition analysis (FAC) [17]. Figure 1D also exhibited of the stearic acid compound can be seen that has increased along with the repetition of the frying and compared with a standard in a range of 4.5-5.1 where the saturated fatty acid of stearic acid is still lower from predetermined standards. It is a major component of various types of fat with different amounts, such as animal fat (beef fat) containing 15-20% and only a little in vegetable oil, 4-5% [31]. Stearic acid lowers LDL and HDL cholesterol concentrations when compared with palmitic acid because these fatty acids are quickly converted to monounsaturated fatty acids and oleic acid interesterification of fats rich in palmitic acid or stearic acid does not appear to affect serum lipid fasting and (apo) lipoprotein [32].

Based on saturated fatty acid results and compared with standard fats and oils, we discover that the oil from repeated frying produces saturated fatty acids that do not exceed the specified standard. This means that repeated frying oil based on palm oil is still safe for consumption because of all the saturated fatty acids found within the reasonable standard range, though that can raise cholesterol levels (myristic acid and palmitic acid). In vegetable oils such as palm oil is dominated by more carbon atoms, whereas in animal oils are odd carbon atoms and contain more polyunsaturated fatty acids (PUFA) [33]. Cooking oil with high saturated fatty acid content will affect the stability of food items that are fried during frying [34,35]. In addition, the high content of fatty acids causes oil to be easily damaged during cooking processing because the oil will be heated continuously at high temperatures and direct contact with oxygen in the surrounding air, which facilitates the oxidation reaction to the oil. According to Baba-Moussa *et al*. [12], an increase in temperature followed by a long heating time indicates that an increase in the fatty acid component forms triglycerides. The result of triglyceride hydrolysis will produce saturated and unsaturated fatty acids based on the presence or absence of carbon chain double bonds in the molecule.

3.2. Unsaturated fatty acids.

The presence of organic constituents in repeated frying oil has been examined that it contains elaidic acid, oleic acid, linoleic acid, cis-11-eicosenoic acid, linolenic acid, and cis-11,14-eicosadienoic acid. Based on Figure 2A the content of untreated cooking oil from elaidic acid showed that 0.09% (0 times), 0.09% (1 time), 0.11% (5 times) and 0.11% (10 times), while the frying oil added 0.03% turmeric extract showed the treatment before frying 0.07% (0 times), 0.09% (1 time), 0.09% (5 times) and 0.09% (10 times). If seen from the frequency of elaidic acid (Figure 2A) that repeated frying can increase the level of elaidic acid and compare with standard <1 that it does not exceed the specified standard. This is because trans fatty acids (TFA) in elaidic acid are unsaturated fatty acids with at least one double bond in the form of trans configuration that can occur naturally from ruminants-based meat and dairy products, or artificially through partial hydrogenation of vegetable oils in industry food processing [36]. Sartika also reported that trans fatty acids (elaidate) were only formed after the second repetition of deep-frying, and their levels increased with the repeated use of oil. Based on the initial formation of trans fatty acids, the frying process should be done on medium heat

(<200°C), and the cooking oil used should not exceed 2 (two) repetitions. Not so in the oleic acid compound (Figure 2B) shows a tendency to vary, if it is compared with the standard of 37.3-40.8. Whereas the recycled frying oil added with 0.03% turmeric extract showed an increase along with the repetition of the frying and when compared with the standard 37.3-40.8. These results indicate that oleic acid is still lower than the standard value.

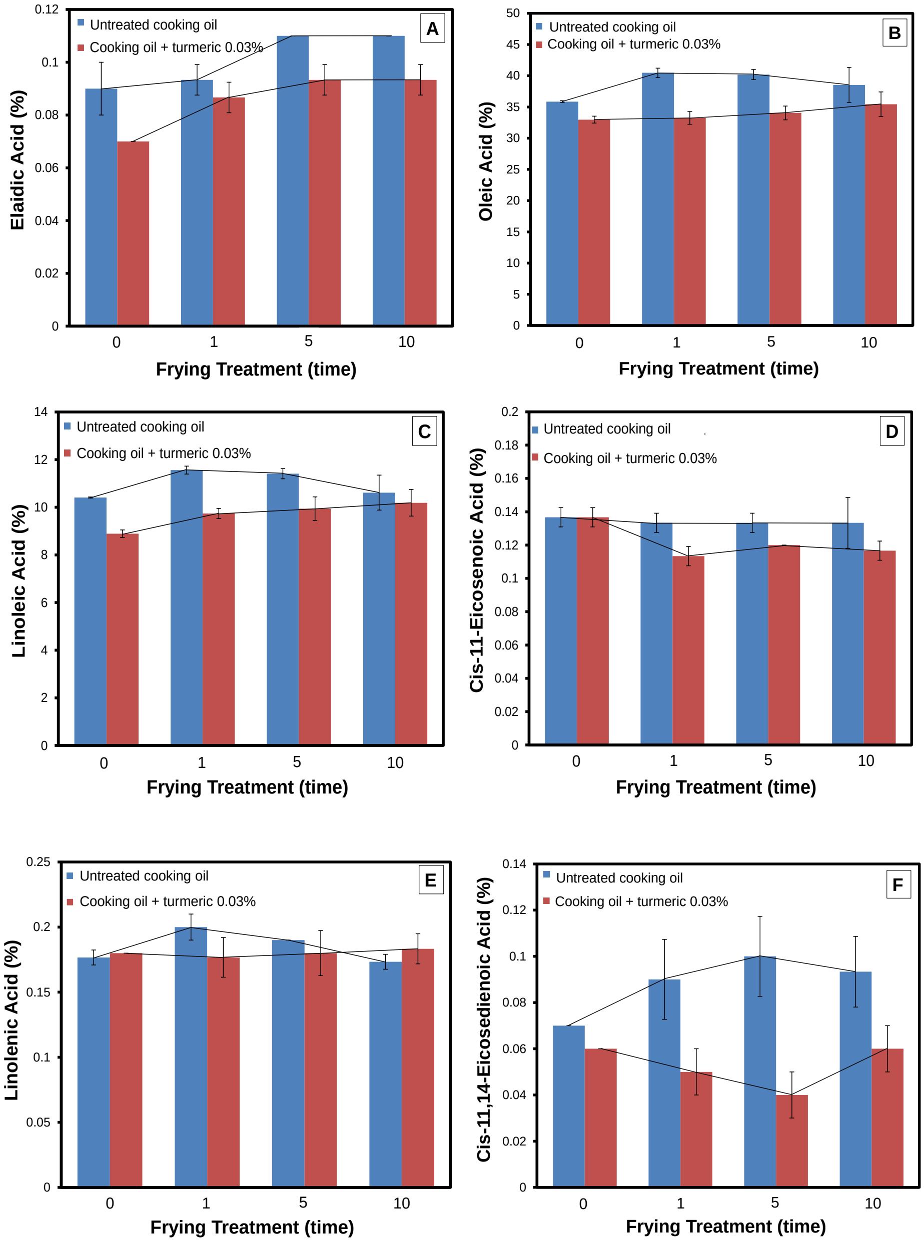

Figure 2. Unsaturated fatty acids component (A) elaidic acid, (B) oleic acid, (C) linoleic acid, (D) cis-11-eicosenoic acid, (E) linolenic acid, and (F) cis-11,14-eicosadienoic acid.

Furthermore, the content of linoleic acid (Figure 2C) in untreated cooking oil showed the same conditions varying when compared with the standard of 9.1-11.0. One that met the standard was the treatment before the tenth frying and frying, while those that do not meet the standards in the first and fifth frying treatment. Then, it compared with frying cooking oil added 0.03% turmeric extract showed an increase along with the repetition of the frying and compared with the standard the first, fifth, and tenth frying have met the standards. Meanwhile, which did not meet the standards in the treatment before the addition of turmeric extract such as the first and fifth frying. This result showed that repeated frying could increase the levels of linoleic acid in the oil from repeated frying by adding 0.03% turmeric extract. It is due to the conjugation of linolenic acid isomer refers to a group of positions and geometrical isomers of omega-3-α-linolenic acid essential acids (cis-9, cis-12, cis-15 C18: 3; ALA) [37,38].

The content of cis-11-eicosenoic acid (Figure 2D) in untreated cooking oil and added 0.03% turmeric extract had decreased levels caused by slow oxidation reactions against cis-11-eicosenoic acid. The frequency of linolenic acid (Figure 2E) in unprocessed cooking oil shows a variable trend. At the beginning of the frying (1 time), there was an increase compared to those not treated, but over time the frying duration decreases. In otherwise, by adding turmeric extract shows a quite static level before frying to the tenth repetition treatment. It shows that turmeric extract can suppress the occurrence oxidation reaction. Meanwhile, Figure 2F depicts cis-11-14-eicosadienoic acid has increased in untreated cooking oil, while the unique by adding turmeric extract dramatically decrease levels. It is concluded cooking oil without treatment has shown increase unsaturated acid levels. The performance of turmeric extract has quite demonstrated efficiency in suppressing chemical reactions during frying treatment [39]. In addition, turmeric extract can function as an antioxidant so that it can inhibit thermal oxidation in cooking oil during repeated frying. This will affect the composition of fatty acids contained in cooking oil. According to Kim and Clifton [40] showed that curcumin (diferuloylmethane) is the main secondary metabolite in turmeric extract, which is beneficial to the human body as antioxidant and anti-inflammatory properties. Curcumin, as a bioactive component, has been shown to be a broad biological action. To date, it has been reported that natural colored extracts are isolated from turmeric by various methods such as maceration, digestion, microwave, and infusion [21]. Turmeric varieties studied by Tanvir *et al*. [18] is a useful source of natural antioxidants and can provide protection against free radical damage. Curcumin can be used as a food additive and is also good for use as conventional medicine [41].

4. Conclusions

This study reports the chemical composition of cooking oil consisting of saturated fatty acids, such as lauric acid, myristic acid, palmitic acid, and stearic acid. Whereas, the unsaturated fatty acids of elaidic acid, oleic acid, linoleic acid, cis-11-eicosedienoic acid, linolenic acid, and cis-11,14-eicosedienoic acid. The highest saturated fatty acid levels in cooking oil before frying, are palmitic acid of 30.88%, whereas unsaturated fatty acids, namely oleic acid of 35.86%. The high saturated fatty acid content in oil cooking before the frying process is palmitic acid of 30.88%, whereas the unsaturated fatty acid is oleic acid of 32.97%. Turmeric extract added to cooking oil can function as an antioxidant so that it can inhibit thermal oxidation in cooking oil during repeated frying. The treatment of repeated frying affects the fatty acids contained in repeated cooking oils, both saturated fatty acids and unsaturated fatty acids.

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Conflicts of Interest

The authors declare no conflict of interest.

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