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Fatty Acid Composition and Cholesterol Indian Mackerel (*Rastrelliger kanagurta*) Due Frying Process

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Abstract

Indian mackarel *(Rastrelliger kanagurta)* contains unsaturated fatty acid Omega-3 which is good for human health. It is commonly consumed as fried dishes. This research was made to determine its composition of fatty acid and cholesterol after frying process in temperature 180°C for 5 minutes. The purposes of this research were to determine its proximate and to analyze profile of fatty acid and cholesterol. Fresh mackarel contained 11 kind SAFA, then to be 9 after frying. MUFA on fresh mackarel decreased from 6 to 5. In addition the highest value of Omega-3 were found for 15.54% DHA and 4.66% EPA, then decreased 80% in persentation make into DHA 2,0% and EPA 0.57%. Fresh mackarel contained 50.54 mg/100 g, cholesterol increased to be 121.63/100 g on wet basis, after frying. The frying process caused the changes of of fatty acid and cholesterol composition on indian mackarel.

Keywords

DHA, EPA, MUFA, Omega-3, Proximate

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1. Introduction

Fish is a fishery products more known to the public than other fishery products. The fish has advantages such as complete amino acid composition. The fish are also known to contain fats that are rich in unsaturated fatty acids that are important for the human body. Fat content in sea water fish reported to be higher than the fat content of freshwater fish and brackish water fish (Nurjanah et al. 2009a). Marine fish that are often consumed by people is mackerel man (Rastrelliger kanagurta). Mackerel contain omega-3 fatty acids which is very good for health. Omega-3 fatty acids can lower blood cholesterol levels and prevent asthma, skin disease, complications of diabetes, and breast cancer. The growth of human brain cells greatly depending on the adequacy of consumption levels of omega-3 as a baby in the womb to toddlers, derivatives of omega-3 are EPA and DHA that is needed by the human body because it has some benefits, which can educate the brain, helps the growth period, and lower triglycerides (Leblanc et al. 2008). Mackerel also contain cholesterol. Cholesterol is an essential element of cell membranes that provide structural support and function as protective antioxiandts. Cholesterol together with sun exposure needed to produce vitamin D. Cholesterol is produced in the body mainly by the liver, but if the excessive production of cholesterol can increase the risk of clogged arteries (Colpo 2005).

Mackerel man is small pelagic fish that usually live in groups. This fish has a high economic value, usually marketed in the form of fresh, salted, smoked, dried or boiled half and used as flour industry. CTF (2013) showed the

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increase in the catch of mackerel man of the year 2010 the number of 17 799 tonnes to 44 240 tonnes in 2012. The increase in the value of catching mackerel making man has the potential to be exploited.

Utilization in many ways can be done to process mackerel so it is ready for consumption. Processing in principle is an attempt to change the mackerel into a form that is different from the nature of its origin. Frying process is one way in processing. Food frying process has been commonly practiced to obtain food cooked in a relatively fast and cause a savory flavor. Fried food always taste better than the processing by boiling and steaming. Frying process causes the oil absorption into the material and will affect especially the nutrient content of fat and protein. Research on fatty acids and cholesterol in the results was carried out by Azrina peraira et al (2015) regarding cholesterol da alpha tocopherol on some fishery products in Malacca, (Purwaningsih et al, 2015) examined the fatty acid composition of fish blodok treated with high temperatures. Nurjanah *et al*. (2015), reported that the mackerel Rastelliger kanagurta to 3 fold after being fried at 180 for 5 minutes, as well as research results. Astina *et al* (2015) in the eel fried rice fields up to several orders of magnitude. Jacoeb *et al.* (2015) about composition of fatty acid, cholesterol and tissues description of fresh and fried red snapper fillet Information on the effect of frying on the composition of fatty acids and cholesterol mackerel man is still so small that research is needed to determine the effect of the frying process, and Ginanjar et al. (2015) about amino acid and taurin indian mackerel.

2. Materials and Methods

2.1. Materials and Tools

The raw materials used are mackerel male and commercial cooking oil (Bimoli). Materials used for proximate analysis is distilled water, 0.1 N HCl, 40% NaOH, selenium catalyst, H_2SO_4, H_3BO_3, 2%, filter paper, cotton fat-free, solvent hexane, 0.1% bromcresol green and methyl red 0, 1%. Materials used for the analysis of fatty acid is 0.5 N NaOH in methanol, BF_3, saturated NaCl, isooktan, Na_2SO_4 anhydrous. Materials used for the analysis of cholesterol, namely alcohol, acetic anhydride, Petroleum benzene and concentrated H_2SO_4. The equipment used for the preparation of raw materials, namely knives, frying process using a deep fryer, and digital scales for weighing. The tools used for proximate analysis is desiccator, oven, furnace, tube sokhlet, pumpkin fat and Kjeldahl tube. The tools used for the analysis of fatty acids include homogenizer, pipettes, Erlenmeyer (extraction of fatty acids), and a vial bottle (methylation), as well as the gas chromatograph Shimadzu GC 2010 plus with standard SupelcoTM 37 Component FAME Mix. Tools for analysis of cholesterol that is UV-200-RS.

2.2. Research Procedure

The study begins with the collection of data origin, size, and yield of mackerel were performed on fresh condition. Proximate analysis, fatty acids, and cholesterol carried in fresh condition and after frying. Mackerel man as much as 30 individuals analyzed morphometric covering a total length, forked length, width, height, and linea lateral (LL). Raw materials were prepared by separating the meat with the skin, head, viscera, and bones for the yield is calculated. The study was conducted with two treatments, ie mackerel and mackerel fresh man cooking man. Fried mackerel will be put into the pot deep fryer oil that already contain as much as 4 L and has been heated at a temperature of 180°C. Mackerel fried for 5 minutes, then the fish is cooled at room temperature. Before and after frying is done weighing to determine weight change mackerel. Meat fresh mackerel and mackerel fried mashed respectively. Fish meat that has been mashed put in aluminum foil and put back into the plastic that has been sealed and coded. Fresh meat and fried mackerel ready for analysis. Proximate analysis methods (SNI 01-2891-1992), fatty acids (AOAC 2005 969.33 grains), and cholesterol (Liebermann-Buchard) conducted by the repeated 2 times for mackerel and fried fresh man.

3. Results and Discussion

3.1. Mackerel Male Characteristics (*Rastrelliger kanagurta*)

Mackerel male body has characteristics such as cigars and covered in scales are small and not easily separated. Forms a flat body with a bigger chest than any other body part, other than that according to Murniyati (2004) mackerel male has blue-green color on the top and bottom yellowish white. Two rows of black spots on the back, a black spot near the pectoral fins. Dorsal fin yellowish gray. The tail fin and yellow chest. Other fins yellowish translucent. This fish has a maximum length of 35 cm with an average length of 20-25 cm. Sample mackerel used can be seen in Figure 1 and morphometric the data shown in Table 1.

Table 1. Results of morphometric and the average weight of mackerel man.

No	Parameter	Unit	Value (x±st dev)
1	raw length	cm	14.4 ± 0.79
2	long forked	cm	13.3 ± 0.72
3	Height	cm	2.76 ± 0.21
4	wide body	cm	1.78 ± 0.20
5	LL	cm	8.47 ± 0.62
6	weights intact	G	31.3 ± 4.07

Description: Data obtained from 30 mackerel

Figure 1. Mackerel Fish (*Rastrelliger kanagurta*).

The results in Table 1 shows the size of the mackerel man who has not yet reached the adult stage. Rifqie (2007) stated that in tropical waters, mackerel men generally reach maturity gonad first time at a length of 175-190 mm forked. Mehanna (2001) states that the size of the mackerel male in the range of 14.3 to 27.7 cm long and weighing in the range of 25-226 g.

3.2. Rendemen

The yield value of a material processing is an important parameter for the basic calculation known financial analysis, estimating the amount of raw materials to produce products in a certain volume, and determine the level of efficiency of a treatment process (Junianto et al. 2006).

The yield of the meat with the skin has a higher percent yield is 66% with a thickness of 0.5-1 cm meat. Mackerel men have thin skin and are not easily separated, according Rifqie (2007) the characteristics of the body of a man like a cigar puffer fish and covered in scales are small and not easily separated so that the calculation of the yield of meat with the skin into one piece. The yield of high value after the head meat with skin and bones with a percentage of 18% and a bone head 8%. Head and spine can be utilized for the source of gelatin and a source of calcium, according to Nurilmala et al. (2006) states that the bone is one of the waste from the fish processing industry has the highest calcium content in the body of the fish, because the main elements of the fish bones are calcium, phosphorus and carbonate. The lowest value owned gills and viscera, offal typically can be used as fertilizer or animal feed.

Treatment with frying techniques cause shrinkage or weight loss (lost) 50% of the weight of the meat with fresh skin. Treatment with frying techniques cause shrinkage or weight loss (lost) 50% of the weight of the meat with the skin. It disebababkan evaporation of water into the air is replaced with fat during frying process, according Kristantina (2013) frying process causes reduction of water content in meat red snapper, the discharge of water in tissues of fish meat would cause components other nutrients are also reduced, namely protein, fat, vitamins and minerals that meat yield will also decrease.

3.3. Chemical Composition

The chemical composition of fresh mackerel highest levels found in the water, then the next highest value found in protein content, while the mackerel fresh ash and fat content has a low value. Results of the proximate analysis mackerel before and after frying can be seen in Table 2. Differences in chemical composition can be influenced by endogenous (internal) and exogenous factors (external). Internal factors influencing the chemical compositions include genetic factors, biota species, sex, size, maturity level of gonads (TKG), and the nature of inheritance, whereas outside factors that affect nutrient content such as temperature, salinity, habitat, season, and species composition and the availability of food (Gokce et al. 2004). Comparison of the chemical composition of the different types of fish that can be seen in Table 3. The chemical composition of the fishery has a high water content, the smaller the size of the fish, the water content tends to be higher. The water content is inversely proportional to the protein content, meaning that increasing the protein content of the lower water content. Protein compounds contained in a water-containing material is chemically bound to the constitution (Nurjanah et al. 2009b).

Table 2. Results of the proximate analysis mackerel and fried fresh.

Chemical composition	Fresh		Fried	
	BB (%)	BK (%)	BB (%)	BK (%)
Water content	76.4 ± 0.15	-	49.6 ± 0.45	-
ash	1.49 ± 0.14	6.33 ± 0.64	2.72 ± 0.07	5.39 ± 0.09
The protein content	18.5 ± 0.31	78.8 ± 1.83	32.4 ± 0.22	64.3 ± 0.14
fat content	0.59 ± 0.10	2.5 ± 0.43	12.5 ± 0.57	24.9 ± 1.08
carbohydrate	2.9 ± 0.70	12.3 ± 2.89	2.65 ± 0.72	5.24 ± 1.40

Tabel 3. Perbandingan komposisi kimia berbagai jenis ikan.

Komposisi Kimia	Mackerel fish (BB%)[1]	bonito (BB %)[2]	Catfish (BB %)[3]	White snapper (BB %)[4]
Water content	76.6 ± 0.48	73.0 ± 0.96	79.6 ± 0.82	71.6 ± 0:23
ash	1.44 ± 0.07	1.79 ± 0.25	1:08 ± 0:02	0.92 ± 0:40
The protein content	16.8 ± 0.56	18.4 ± 0.27	15.5 ± 0:19	18.4 ± 0:43
fat content	3.89 ± 0.24	4.26 ± 0.05	2:51 ± 0:45	4:18 ± 0:26
carbohydrate	1.15 ± 0.08	2.76 ± 0.21	-	-

Water is a basic component of fish, about 80% of the portion of meat that can be eaten. The water content of mackerel after frying process there is a change. The water content of mackerel 76.4% and 49.6% with fresh and fried, research Rahman et al. (2012) mackerel fresh man has a water content of 76.6% after frying duhu 180°C for 15 minutes has a water content of 20.39%. High levels of water because of the water that is not tied into the network of a substance or pure water with unusual properties and full activity. A decrease in water content after frying process due to the evaporation of the

water is replaced by fat and the length of time the frying pan, so the longer frying time, the more water will evaporate and be replaced by oil.

The ash content of a food indicates total minerals contained in the food material (Winarno 2008). Results of ash content in fresh mackerel of 1.49%, while the fried mackerel increased the ash content is 2.72%, according to research conducted Susilawati (2002) ash content in some types of fish with frying treatment showed average figures 0.60% - 1.15% on fresh fish, while the fish fry showed the average rate of 2.00% -3.30%. Differences ash fresh mackerel can be caused by the amount of minerals contained in different foodstuffs. The mineral content of a material can be increased when the frying process because palm oil containing phosphorus, iron and cuprum (Hasibuan and Nuryanto 2011).

The protein content in fresh mackerel gained 18.5%, while 32.4% puffer fish fry. Increased protein levels wet basis after the frying process is caused by a decrease in water content after frying so that the protein content increased proportionately. The chemical composition of the protein will be different after the removed water content is 78.8% fresh mackerel and mackerel fry 64.3%. A decrease in the protein due to the frying process. Meat protein is unstable and has the properties can be changed (denatured) with changing environmental conditions (Georgiev et al. 2008). Denaturation may imply a change or modification to the structure of secondary, tertiary, and quaternary protein molecule without breaking the covalent bonds (Jacoeb et al. 2008). Denaturation process of changing the physiological properties of the protein but does not cause total nitrogen in food decreased. Calculation of protein content on this test is to test the total nitrogen that is in the food (crude protein). Allegedly there are other components in the form of non-protein nitrogen which are calculated in this study.

Fat content in fresh and fried mackerel on a wet basis, namely 0.59% and 12.5%. Once the water content is removed, the value of fresh and fried mackerel was 2.5% and 24.9%, increase in fat levels can be caused by the influx of oil-containing fats and replace the water that is in the food. During the frying process takes place, the majority of oil into the crust and the outer part (outer zone) so that it fills the empty space that was originally filled by water. Frying process used cooking oil as a medium of heat. Oil is absorbed partly by the fried fish. Fat content increased due to the frying process. The water lost due to evaporation will be filled by oil (Susilawati 2002). Used cooking oil as a heat transfer medium during frying fish, mackerel absorbed by the meat so that the fat content found in cooking oil also absorbed. Foodstuffs will absorb some oil during frying. Excessive absorption can be reduced with the new drain fried food (Muchtadi and Ayustaningwarno 2000).

Analysis by the difference in carbohydrate content showed the value of 2.9% on fresh bloating and 2.65% in fried puffed. Okuzumi and Fuzii (2000) states that the glycogen content contained in fisheries products amounted to 1% for fish, and 1% for crustaceans. Carbohydrate content in fish is usually very little that ranges between 0.1-1% (Nurjanah and Abdullah, 2010). Analysis by difference suggests that storing fresh mackerel are high in carbohydrates. Ningsih (2011) states that the presence of carbohydrates in food sometimes is not alone, but alongside other nutrients ie protein and fat, but it can also contain meat diktiosom assemble components of carbohydrates. Carbohydrates on fishery products do not contain fiber, mostly in the form of glycogen consisting of glucose, fructose, sucrose, and other monosaccharides.

Fatty Acid Composition

Saturated fatty acids (SAFA) show on mackerel meat fresh man a total of 11 types, while after fried turned into 9 types. The content of saturated fatty acids most commonly found in mackerel, namely myristic fatty acid (C14: 0), palmitic fatty acid (C16: 0) and stearic fatty acid (C18: 0). Palmitic fatty acids increased after frying from 16.1% to 29.2%, while saturated fatty acids myristic and stearic decreased. Myristic fatty acids decreased from 3.42% to 1.09% and stearic fatty acids decreased 6.57% to 3.78%. It can be derived from palm oil or used cooking oil that contains a high palmitic fatty acid palmitate will be entered into materials that are fried. Palmitic acid is also a major component of total saturated fatty acids is 53-65% (Ozugul and Ozugul 2007). Palmitic acid content were increased according to the research conducted by Alireza et al. (2010) that the palmitic acid oil may rise after deep fat frying process. The composition of fatty acids in the meat with the skin mackerel and fried fresh man presented in Table 4

Monounsaturated fatty acids (MUFA) fresh mackerel showed the number as many as 6 different types, while the fried mackerel are 5 types. Oleic fatty acid (C18: 1N9) has the highest value before and after frying and the highest grade after oleic fatty acid is palmitoleic fatty acid (C16: 1). Oleic fatty acid content has increased 7-fold after frying is 4.46% to 30.6%. Increased levels of oleic acid in the meat with fried mackerel skin caused by frying. Change after frying due to the mixing of oleic acid derived from cooking oil, oleic content in palm oil 30.91% (Abiona et al., 2011). Research Domiszewski et al. (2011) also showed that oleic fatty acid is the highest MUFA on fresh meat and fried catfish, which amounted to 37.59% and 62.33%. Oleic acid has a function in the body is as an energy source, as antioxiandts to inhibit cancer, lowering cholesterol levels and solvent media vitamins A, D, E, and K. oleic acid deficiency can cause

interference with vision, memory loss and impaired the growth of brain cells in fetuses and infants (Peddyawati 2008). Palmitoleic fatty acids decreased from 2.51% to 0.46% after the frying process. This is caused by the oxidation of fatty acids that occur when frying. Oxidation damage occurs in unsaturated fatty acids, but when the oil is heated at a temperature of 100°C or more, saturated fatty acids can be oxidized (Sartika 2009).

Table 4. Composition of fatty acids in mackerel fish.

Fatty Acid	Fresh (%w/w)	Fresh mackerel*	Palm oil **	Mackerel fried (%w/w)
Saturated fatty acids (SAFA)				
Lauric (C12: 0)	0.06 ± 0.01	tt	tt	0.13±0.01
Tridekanoat (C13: 0)	0.07 ± 0.01	tt	tt	tt
Myristat (C14: 0)	3.42 ± 0.06	1.04	0,88	1.09 ± 0.06
Pentadekanoat (C15: 0)	0.82 ± 0.03	tt	tt	0.13 ± 0.01
Palmitic (C16: 0)	16.1 ± 0.90	3.26	4.26	29.2 ± 2.03
Heptadekanoat (C17: 0)	1.02 ± 0.04	0.98	tt	0.20 ± 0.01
Stearic (C18: 0)	6.57 ± 0.49	0.98	813	3.78 ± 0.35
Arakhidat (C20: 0)	0.57 ± 0.03	0.81	0.29	0.33 ± 0.01
Heneikosanoat (C21: 0)	0.15 ± 0.01	tt	tt	tt
Behenic (C22: 0)	0.26 ± 0.01	0.16	tt	0.09±0.01
Lignocerat (C24: 0)	0.19 ± 0.01	0.32	tt	0.08±0.01
Sum	29.23			35.03
Monounsaturated fatty acids (MUFA)				
Erukat (C22: 1N9)	0.39 ± 0.04	tt	tt	tt
Palmitoleic (C16: 1)	2.51 ± 0.08	0.16	tt	0.46 ± 0.06
Elaidic (C18: 1n9t)	0.08 ± 0	tt	tt	0.1 ± 0.01
Oleic (C18: 1n9c)	4.46 ± 0.34	tt	30.91	30.6 ± 1.87
Cis-11-Eikosenoat (C20: 1)	0.24 ± 0.01	0.98	0.35	0.17 ± 0.01
Nervonat (C24: 1)	0.35 ± 0.02	tt	tt	0.05 ± 0
Sum	8.03			31.47
lural unsaturated fatty acids (PUFA)				
Linoleic (C18: 2n6c)	1.18 ± 0.06	16.5	9.23	8.54±0.45
g-linoleic (C18: 3n6)	0.16 ± 0.01	1.95	tt	tt
Linolenic acid (C18: 3n3)	0.75 ± 0.03	2.44	0.26	0.39±0.15
Cis-11.14-Eikosedienoat (C20: 2)	0.24 ± 0.01	0.16	tt	0.07±0
Cis-8,11,14-Eikosentrienoat (C20: 3n6)	0.14 ± 0.01	0.33	tt	tt
Linolelaidat (C18: 2n9t)	0.07 ± 0.01	tt	tt	tt
Arachidonic (C20: 4n6)	2.36 ± 0.16	0.33	tt	0.31±0.03
13 cis, 16-Dokosadienoat (C22: 2)	0.06 ± 0.01		tt	tt
Cis-5,8,11,14,17-EPA (C20: 5n3)	4.66 ± 0.1	4.72	tt	0.57±0.01
Cis-4,7,10,13,16,19-DHA C22: 6n3)	15.54 ± 1.09	14.5	tt	1.99±0.01
total PUFA	25.16			11.87
Total fatty acids	62.42 ± 3.54			78.37 ± 5.06
Not identified	37.58			21.63
number n3	20.95			2,95
number n6	3.84			8.85
n6 / n3	0.18			3

Unsaturated fatty acids have a double bond or plural known as PUFAs thus more vulnerable to attack by oxygen. The content of PUFA in fish fresh mackerel totaled 10 species, while the fried mackerel dwindling into 6 types. Fresh mackerel have a high in PUFA linoleic acid, arachidonic acid, EPA, and DHA. Frying causes a very significant decrease. The data obtained show the value of the fatty acid linoleic (C18: 2n6c) increased after frying from 1.18% to 8.54%. It can be caused due to the content of the palm oil for frying process contains linoleic acid amounted to 9.23% (Abiona et al., 2011) that can increase levels of linoleic fatty acids. Research Ningsih (2011) stated that the increase in the content of linoleic catfish meat affected by linoleic content contained in cooking oil, cooking oil which contains linoleic amounted ie 10.88%.

Arachidonic fatty acid (C20: 4n6) on fresh mackerel showed the percentage of 2.36%, whereas after frying decreased, ie by 0.31%. The decline may be due to the double bond in the fatty acid. This can be caused by oxidative decomposition of unsaturated fatty acids during the heating process at high temperature more easily occur because the double bonds more easily attacked by oxygen Winarno (2008). EPA and DHA fatty acids can improve cardiovascular health through several mechanisms. Both reduce the viscosity of blood without a significant effect on platelets or clotting, have a positive effect on blood lipids, and consistent with the reduction in the concentration of triglycerides (Uandi and Ritz 2013). Alpha linolenic acid may be extended for EPA (C20: 5n-3) and DHA (C22: 6n-3) through the extension and desaturation (Kromhout et al. 2012).

EPA and DHA fresh mackerel man amounted to 4.66% and 15.54%. This result is not much different from the research Osman et al. (2001) show the EPA content in fresh mackerel amounted to 4.72%, DHA itself on fresh mackerel 14.5%, DHA content was higher in this study. Frying causes a decrease in the content of EPA and DHA on mackerel, EPA and DHA decrease of 0.57% and 1.99% the percentage reduction in EPA and DHA own approximately 80% from prior to the frying process. EPA and DHA can decrease resulting from heating is done, essential fatty acids EPA and DHA that is sensitive to light, temperature and oxygen. Double bonds in unsaturated fatty acids readily react with oxygen (easily oxidized) (Tambun 2006). This is supported by studies Arias et al. (2003) about the influence of different processing methods on chemical composition and fatty acid content Sardine pilchardus stating that DHA decreased after treatment with heat.

3.4. Content of Cholesterol

Results of the study showed the average value of cholesterol in men fresh mackerel is 50.54 mg / 100 g. Research Osman et al. (2001) shows the cholesterol values mackerel does not differ greatly in the amount of 49.1 mg / 100 g. Variations cholesterol is influenced by several factors such as species, food availability, age, sex, water temperature, geographic location, and season (Sampaio et al. 2006). Cholesterol content increased in the amount of 121.63 mg / 100 g after frying. This can be caused by increased fat content in food can lead to increased cholesterol content in the material. Abiona et al. (2011) stated content of saturated fatty acids in coconut oil may increase cholesterol content in the ingredients are fried. Palm oil is used to contain phytosterols. Phytosterols containing 28-29 atom steroid alcohol. Phytosterols and cholesterol have the same structure but phytosterols have an extra methyl or ethyl chain branches. The main phytosterols in palm oil is sitosterol 350-410 ug / g of oil, campesterol 140-180 ug / g of oil, stigmasterol 70-100 ug / g of oil, and avenasterol 0-30 ug / g of oil (Tabee 2008). Liebermann - Colour Reaction Buchard used in calculating the levels of cholesterol in the sample is a method with the extraction step. This method of calculating the levels of cholesterol and other sterols contained in the material (Kenny 1952). This allows the uncountable number of other sterols in materials other than cholesterol. Another starting sterol can be derived from sterols contained in cooking oil.

4. Conclusion

Fresh mackerel man having fatty acid content of 11 SAFA and after frying turned into 9 SAFA, the highest saturated fatty acids in Myristat (C14: 0), palmitic (C16: 0) and stearic (C18: 0). Palmitic acid increased after frying. Palmitic acid is the main component in the origin of saturated fat. MUFA on fresh mackerel amounted to 6, while after frying amounted to 5 MUFA, monounsaturated fatty acids with the highest score is palmitoleic (C16: 1) and oleic (C18: 1n9c). Oleic acid increased after frying. The content of omega-3 PUFA mainly on fresh mackerel have a high enough value, after frying the value of Omega-3 EPA (C20: 5n3) and DHA (C22: 6n3) decreased by the percentage decrease of 80%. The average cholesterol content in fresh mackerel amounted to 50.54 mg / 100 g and the mackerel fried cholesterol rose by 121.63 mg / 100 g.

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