

Effect of different fish cooking method on plasma lipid levels healthy young adults in Kendari, Southeast Sulawesi

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Abstract

Some nutrients contained in fish, particularly unsaturated fatty acid, have atheroprotective effect by lowering on total cholesterol, triglyceride, and Low Density Lipoprotein (LDL), and increasing High Density Lipoprotein (HDL). Quantities of fatty acid vary considerably by cooking and preservation methods. Cooking and preservation methods is important to be considered because some methods of cooking can alter nutrition profiles, particularly fatty acid profiles. The aim of this study was to evaluate the different fish cooking method on blood lipid levels. Cooking method was measured by Semiquantitative Food Frequency Questionnaire (SQFFQ). Subject was interviewed about their fish cooking habits in a last month. Plasma lipid concentrations were measured enzymatically by Cholesterol Oxidase-Peroxidase Aminoantipyrine Phenol (CHOD-PAP) method. There was no different statistically ($p > 0.005$) on plasma lipid levels (triglycerides, total cholesterol, LDL, and HDL) between fried and nonfried fish consumption. No significance correlation between cooking method and plasma lipid levels. Different fish cooking method was not affect the plasma lipid levels. Total fish intake was more dominant than cooking method to affect the plasma lipid. Consuming fried fish with no flour layered, and not using hydrogenated oil may give beneficial effect on plasma lipid.

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Introduction

Fish has long been recognized as a valuable source of high-quality protein in the human diet. In recent years, fish lipids have also assumed great nutritional significance, because of their high polyunsaturated fatty acid (PUFA) levels (Puwastien *et al.*, 1999). PUFA omega-3 specifically eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), have been shown to have cardioprotective effects (Kris-Etherton *et al.*, 2002; Mozaffarian *et al.*, 2006; Gebauer *et al.*, 2006). A Linolenic acid, a plant-derived fatty acid, can be elongated to form EPA and DHA, but this bioconversion is limited in humans (William *et al.*, 2006; Arterburn *et al.*, 2006). Polyunsaturated fatty acids can reduce blood LDL-cholesterol and have anti thrombotic, antiinflammatory, antiarrhythmic and vasodilatory properties (Lombardo and Chicco, 2006). Hence, PUFA omega-3 may help to prevent coronary heart disease, hypertension, diabetes type 2 and insulin resistance.

Therefore, many observational epidemiological studies have examined fish consumption as a surrogate for omega-3 PUFA intake and this

approach is supported by studies showing associations between fish intake and biomarkers of PUFA omega-3 (Andersen *et al.*, 1996; Hjartaker *et al.*, 1997). Quantities of omega-3 PUFA vary considerably among fish species, by season, and by cooking and preservation methods (Kris-Etherton *et al.*, 2002). Heating (boiling, grilling, baking, and frying) is applied to food to enhance its flavour and taste, inactivate pathogenic microorganisms and increase shelf life (Bognar, 1998). The major changes that occur during processing and final preparation of heated food are due to oxidation. The PUFA omega-3 such as EPA and DHA, are considered to be especially susceptible to oxidation during heating and other culinary treatments. Autooxidation of PUFA is catalysed by heat, light, trace metals or enzymes and involves free radical generation. Free radicals propagate autooxidation by reacting with oxygen to form hydroperoxides, which breakdown to generate other new free radicals (Sant'Ana and Mancini-Filho, 2000).

Frying method with high temperature (200-250°C) will break the double bond in unsaturated fatty acids to be saturated fatty acids that risky to higher

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blood cholesterol. A fat-soluble vitamin also change so the nutritional function of cooking oil will decline even negative effect on health (Weber *et al.*, 2007). The research by Chung *et al.* (2008) indicating that fried fish is not a good source of long-chain omega-3 PUFA. This could be explained in part by the low content of long-chain omega-3 PUFA in fish often prepared fried. Additionally, frying itself can alter nutrition profiles, particularly fatty acid profiles, by absorbing omega-6 fatty acids from cooking oils and adding trans-fatty acids (Candela *et al.*, 1998).

The other way, Gladyshev *et al.* (2006) studied the effect of cooking on the essential polyunsaturated fatty acids in muscle tissue of humpback salmon, the samples were fried, boiled, roasted and boiled in a small amount of water, and they found that heat treatment did not decrease the EPA or DHA content during each method except for a moderate reduction found in the salmon that was fried. On the other hand Al-Saghir *et al.* (2004) studied the effects of different cooking procedures on lipid quality of farmed salmon. They cooked the salmon by steaming or pan frying with olive oil, corn oil, or partially hydrogenated plant oil or without oil. They found that there was insignificant exchange between the oil and the salmon, but there were slight differences in fatty acid pattern according to the oil used. No change was found in the omega-3 fatty acid content with cooking method and no difference frying with or without oil.

Southeast Sulawesi is one of the provinces in Indonesia which has a good habit in diet through high in fish consumption, exceeding the recommendation of fish consumption from American Heart Association (2006), for consume oily or fatty fish twice per week (8 grams). But almost of them consumed fried fish. Frying is the most favourite method to preserve and cook their fish. The aim of this study is to investigate the relationship between fish consumption habits and lower incidence of cardiovascular diseases in Southeast Sulawesi.

Materials and Methods

This study is cross-sectional design, performed in Kendari City, Southeast Sulawesi, and was conducted on September 2015. Kendari was chosen purposively based on data of Indonesian fish consumption and production from Indonesian Ministry of Marine Affairs and Fisheries. Southeast Sulawesi is one of province which have high in marine fish production and consumption. This research was carried out after getting an Ethical Approval letter number KE/FK/1113/EC/2015 from the Commission of Ethics, Faculty of Medicine, Gadjah Mada University. Total

subject were 135 people, obtained through sampling formula for correlative study. The participants were male and female 20-40 years old, did not suffer or have not been diagnosed with symptoms of Cardiovascular Diseases (CVD) such as: dyslipidemia, hypertension, heart disease, stroke; and did not consume lipid or tension altering drugs. Subject recruited from 3 districts in Kendari: West Kendari, Kambu, and Kadia. Three of ten districts in Kendari City selected as sampling points were determined purposive based on the height above sea level due to the geographical conditions of Kendari consist of coastal and plateau. They were West Kendari (0-5 meters above sea level), Kambu (6-10 meters above sea level), and Kadia (> 10 meters above sea level), with each district were taken 50 subject, in case there were subject who resign or the blood samples was missing. Sampling was performed by consecutive sampling technique.

The subject characteristics form was used for assessed personal data and medical history. There were demographic characteristic including address, gender, age, education level, occupation, income in a month, medical history, exercise habits, smoking and alcohol habits. Habitual diet over the past month were assessed using SQFFQ. Plasma lipid concentrations were measured enzymatically by CHOD-PAP method.

Subject were interviewed related to personal data and medical history using questionnaire subject characteristics, then interviewed about fish consumption in a past month, consumption of saturated fat, consumption of cholesterol and fiber using SQFFQ by trained nutrition enumerators. The SQFFQ consist of list name spesies of fish in Kendari; list of some foods which known as a source of saturated fat and cholesterol (lard, pork, lamb, beef, egg, cheese, fullcream milk, coconut milk, liver, coconut oil, shrimp, shell, butter), and fiber (vegetables, fruits, legumes, oat, tubers, sago); frequency of consumption in a month (>3x/day, 2-3x/day, 1x/day, 3-6x/ week, 1-2x/week, 1x/ 2 weeks, 1x/month, never); grams in each consumption, and how to cook (cooking method). Before using in this study, the questionnaire was validated in Kendari.

The blood samples 3 ml was taken from vena by doctor then centrifuge to separate the serum in Bhayangkara Hospital Laboratory, and analyzed enzymatically in Regional Health Laboratories Yogyakarta used CHOD-PAP method. Quantity of fish consumption is total fish that was consumed in grams of each type within a certain period. Data measured by SQFFQ then categorized into high if the average consumption of fatty fish ≥ 25 g/day or lean fish ≥ 50 g/day, and low if the average consumption of fatty fish < 25 g/day or lean fish < 50 g/day. Fish

type was grouped into fish conditions and content of omega-3 fatty acids. Based on the conditions, the fish was grouped into fresh (raw fish) and preserved fish including dry fish, salt fish, pickle fish and smoke fish. Fatty fish is a fish that contain high unsaturated fatty acids omega-3 (with at least one gram of omega-3 per 100 g) and lean fish is a fish that contain low unsaturated fatty acids omega-3 (with < 1 g of omega-3 per 100 g).

Cooking method is process to cook the fish from raw becoming ready to be eaten with method that affect composition of fatty acids. Cooking methods grouped in to recommended and not recommended methods. Recommended method is a method of cooking that not reduce the content of unsaturated fatty acids omega-3 including baked, boiled, and steamed. Non-recommended method is a method of cooking that reduce the content of unsaturated fatty acid omega-3 that is fried method.

Plasma lipid levels including triglycerides, total cholesterol, LDL-cholesterol and HDL-cholesterol in the blood serum. Data were categorized into normal if < 200 mg/dL and high if \geq 200 mg/dL for total cholesterol; normal if \geq 60 mg/dL and low if < 60 mg/dL for HDL-cholesterol; normal if < 130 mg/dL and high if \geq 130 mg/dL for LDL-cholesterol; normal if <150 mg/dL and high if \geq 150 mg/dL for triglycerides.

The smoking habit is the number of cigarettes was spent a day. Data categorized into not smoking, smoking 1-10 cigarettes per day, smoking 11-20 cigarettes per day, and smoking > 20 cigarettes per day. Consumption of alcohol is a habitual of drinking alcohol. Physical activity is a habitual to physical activity that increase energy expenditure or calorie burning and in sufficient time of 30 minutes/day, every day or 3-5 times/ week. Saturated fat intake is a consumption of foods containing saturated fats that are categorized into recommended if the average intake of saturated fat < 28 g/day, and not recommended if the average saturated fat intake > 28 g/day. Cholesterol intake is habitual consumption of foods containing high cholesterol which is categorized into recommended if the intake of cholesterol <300 mg/day, and not recommended if the average intake of cholesterol \geq 300 mg/day. Fiber intake is the number of fruit and vegetable consumption. Data are categorized recommended if the average consumption of fruits and vegetables \geq 5 servings/day, and not recommended if the average consumption of fruits and vegetables < 5 servings/day.

Data were analyzed using Strata 12. Bivariate analysis was performed to know the relationship

between independent and dependent variables, external and dependent variables using Spearman's correlation test, comparative test Mann-Whitney test, and Kruskal Wallis test. Multivariate test were performed when the bivariate test obtained by value $p > 0.25$. Multivariate test was used in this research is multiple linear regression.

Result

The subject were male or female living in Kendari City, particularly in Kambu, Kadia, and West Kendari districts, 20-40 years, and was not in exclusion criteria. The study population included 135 subject: 53 male and 82 female. The majority of subject (61%) were female, aged <30 years (74%), high school educated (48%), and not or do not work (66%). Most subject have not exercise regularly (58%), do not smoke (87%), and do not consume alcohol (96%). Saturated fat intake level of subjects still as recommended (100%), cholesterol intake was appropriate recommendation (91%), but fiber intake was not as recommended (84%). The average intake of saturated fat, cholesterol intake, and fiber intake were 7.08 g/ day, 192.29 g/ day, and 12.52 g/ day.

Most subject (83%) consumed fish in high category, consumed fatty fish (51%), and in fresh condition (99%) but cooked by not recommended cooking method (73%). The average of fish consumption in the group of fatty fish was 104.29 g/ day, while the lean fish was only 63.32 g/day. The average of total fish consumption was 167.61 g/ day with serving of fatty fish larger than lean fish. Majority of subject had a normal lipid levels. The average level of subject triglycerides was 114 mg/dL, with minimum value 33 mg/dL and maximum value 501 mg/dL. Average level of HDL subjects was 58.61 mg/dL with minimum value 26 mg/dL and maximum value 125 mg/dL. The average level of LDL was of 81.13 mg/dL with minimum value 26 mg/ dl and maximum value 163 mg/dL. Meanwhile, the average value of total cholesterol subject was 161.59 mg/dL with minimum value 89 mg/dL and maximum value 282 mg/dL.

There was a negative correlation between the quantity of fish consumption and lipid profile. This indicates that higher quantity of fish consumption, lower the blood lipid levels. All lipid profiles have r value <0.4, indicates that the statistical strength of the correlation between the quantity of fish consumption and lipid levels are still relatively weak. However, the quantity of fish consumption has a significant correlation ($p < 0.05$) with the levels of triglycerides and cholesterol total. There was no significant

Table 1. Distribution of subject characteristic

Subject characteristic	Category	N	%
Gender	Female	82	61
	Male	53	39
Age	< 30 year	100	74
	30-40 year	35	26
	40-50 year	15	11
Education level	Elementary	19	14
	Junior high school	10	8
	Senior high school	65	48
	Academy	41	30
Occupation	House wife/ students	89	66
	Civil servant	14	10
	Private	32	24
Exercise	Yes	57	42
	No	78	58
Smoking habit	Not smoking	118	87
	< 10 cigarettes/day	12	9
	10-20 cigarettes/day	5	4
	>20 cigarettes/day	0	0
Alcohol habit	Yes	5	4
	No	130	96
Saturated fat intake	As recommended	135	100
	Not as recommended	0	0
Cholesterol intake	As recommended	123	91
	Not as recommended	12	9
Fiber intake	As recommended	21	16
	Not as recommended	114	84

difference statistically in blood lipid profiles between groups of fatty fish and lean fish. There was no significant difference statistically in blood lipid profiles between groups of recommended cooking method and not recommended cooking method.

After controlled by external variables, the quantity of fish consumption, saturated fat intake were the most associated variables with triglyceride level. Adjusted R-squared value obtained at 0.1207 which means that the three independent variables can explain variations in triglycerides by 12.07%. The rest, 87.93% influenced by other variables outside the regression model. Variables associated with HDL level were fiber intake and gender, with the ability to explain the variation was 5.59%. The adjusted R-squared value was 0.0588, which means that most of the variation in LDL levels (94.12%) is determined by variables outside of the regression equation. Total cholesterol was associated with the quantity of fish consumption with the ability to explain variation in accordance regression equation, amounted to 9.90%. All of the equation have values of F-test (Prob>F) <0.05, which means that all independent variables simultaneously have significant influence on the dependent variable.

Discussion

The most of subjects, both male and female have normal levels in triglycerides, total cholesterol, HDL, and LDL. This condition was consistent with the previous study that there were no significant

Table 2. Quantity of fish consumption, type of fish, and cooking method

Variable	Kategori	N	%
Fish consumption	High	112	83
	Low	23	17
Fish type	Fatty fish	68	51
	Lean fish	67	49
	Fresh	134	99
	Non-fresh	1	1
Cooking Method	Recommended	36	27
	Non-recommended	99	73

differences in lipid profiles between male and female (Van Lennep *et al.*, 2002). In this study, the average levels of male's HDL lower than female. Based on multivariate analysis, gender is one of the dominant variables associated with HDL level. It was in line with the results of studies which claim that HDL level will be increased by estrogen, so that the pre-menopausal female tend to have higher HDL levels (Stevenson *et al.*, 1993; Davis *et al.*, 1994; Tremollieres *et al.*, 1999).

The group with age <30 years has lower average in levels of triglycerides, LDL, and total cholesterol compared to 30-40 years age. Significant increasing in lipid profile in male started on thirties and forties. Likewise in female, as increasing of their age and approaching menopause, estrogen levels will decrease which causes increasing levels of triglycerides, LDL, and cholesterol increased, and decreasing HDL levels. The risk of CVD increase with age, and a sharper increase occurred in female (Jousilahti *et al.*, 1999).

There was no significant difference statistically in the lipid profile between subjects who has physical activity regularly and the group has not. Statistical analysis showed no significant difference in lipid profile group of smokers and nonsmokers. Statistical analyzed also showed that no significant difference in lipid profile between subject who consuming alcohol and did not.

In saturated fat and cholesterol intake, the results showed that no significant correlation with all the lipid profile, but multivariate analysis showed that saturated fat intake was one of the dominant variables associated with triglyceride levels, but with negative correlation. There was not in line with biological plausibility, which high intake in saturated fat will increase body fat deposits in the form of triglyceride.

Majority of subjects in this study was not sufficient in fiber intake in accordance with the recommended ≥ 5 servings/day or approximately 30 g/ day for total fiber intake. The subjects who have fiber intake appropriate as the recommended servings has levels of triglycerides and total cholesterol lower than they did not, although not significantly associated. Total fiber intake was negatively correlated with the levels

Table 3. Distribution subject based on category in plasma lipid levels

Plasma lipid profile	Category	N	%
Triglyceride	Normal	108	80
	High	27	20
HDL-C	Normal	123	91
	Low	12	9
LDL-C	Normal	129	96
	High	6	4
Total cholesterol	Normal	118	87
	High	17	13

of triglycerides and total cholesterol, in the sense that higher fiber intake, lower the levels of triglycerides and total cholesterol. Based on multivariate analysis, fiber intake is the dominant variable related to levels HDL (Truswell, 2003).

The average of quantity fish consumption of subjects was categorized high, 167.61 g/ day. This number exceeds the fish consumption advice from American Heart Association, at least 50 g/ day to get (n-3) PUFA to meet the body's need for EPA and DHA, at least 1 g/ day (Kris-Eherton et al., 2003; Indonesian Ministry of Health, 2013). Consumption of fish, especially fish rich in (n-3) PUFA, helps improve blood lipid profile. The results of this study prove that there was a negative correlation between the quantity of fish consumption with levels of triglycerides, total cholesterol, and LDL. That is, the higher fish consumption, the lower levels of triglycerides, total cholesterol, and LDL. The inverse correlation was statistically significant at levels of triglycerides and total cholesterol.

Controlled by the external variables, the quantity of fish consumption was the most dominant variable associated with levels of triglycerides and total cholesterol levels. This condition is consistent with the results of a study that the decrease in the levels of triglycerides in hyperlipidemic subject supplemented with fish oil (Eslick et al., 2009). Results of other studies also prove the existence of a significant difference in triglycerides and cholesterol lipid profile samples that thirty years not eating fish, with high consumption of fish in the category of rare, medium, and often (Panagiotakos et al., 2007).

In this study, LDL and HDL levels were negatively correlated with the quantity of fish consumption but not significant. This is consistent with findings in previous studies that suggested a negative correlation between the quantity of consumption of fish with high levels of LDL (Vasquez et al., 2014) and a positive correlation of the quantity of fish consumption with high levels of HDL (He et al., 2008), but some studies suggest in contrast (Illingworth et al., 1984; He et al., 2008). Polyunsaturated fatty acids can lower levels of LDL but also lower HDL levels,

Table 4. Correlation between fish consumption, fish type and cooking method and lipid profile

Variable	Lipid Profile			
	Triglyceride	HDL-C	LDL-C	Total cholesterol
Fish consumption	r = -0.225 p = 0.009	r = -0.057 p = 0.515	r = -0.124 p = 0.153	r = -0.239 p = 0.005
Fish type	p = 0.939	p = 0.638	p = 0.404	p = 0.793
Cooking method	p = 0.827	p = 0.263	p = 0.603	p = 0.644

while monounsaturated fatty acid can lower LDL cholesterol and raised levels of HDL (Wood et al., 1993).

An important mechanism of the protective effects of (n-3) PUFA contained in fish and fish oil to reduces the risk of heart disease is by lowering triglyceride concentrations by pressing the hepatic secretion triglycerides along with encourage the cleaning of triglycerides in plasma (Harris et al., 2008). Long-chain (n-3) PUFA also lowers the production of chemoattractant, growth factors, and adhesion molecules that could inhibit leukocyte migration processes that deliver smooth muscle to intima section vessel wall (Hughes et al., 1996; Baumann et al., 1998). Anti-inflammatory effect that can reduce the inflammation in the vessel wall, which is the first contributor to the incidence of atherosclerosis, also owned by PUFA omega-3 (Calder, 2003). In a meta-analysis was also mentioned that the PUFA omega-3 have a hypotensive effect, both in subject with hypertension and normotension (Geleijnse et al., 2002). This fatty acid also causes relaxation of arterial endothelial and encourage compliance with regard to changes in the production of nitric oxide (Harris et al., 1997). Overall, they are some of the effects of PUFA omega-3 in an attempt to hinder the process of atherosclerosis.

In this study, the average quantity of consumption of fatty fish higher than the average quantity of consumption of lean fish. The average levels of triglycerides, total cholesterol, and LDL in the group of fatty fish lower than lean fish group, although the difference was not statistically significant. This is consistent with the theory that consumption of fatty fish types will increase the levels of PUFA omega-3 and DHA in the serum more than lean fish, but not directly related significantly with lipid profile in the blood (Bogl et al., 2013; Erkkila et al., 2014). However, other studies showed a negative and significant correlation between lean fish consumption with the risk of stroke in women. In that study, the consumption of fatty fish increase the risk stroke by increasing OR value (Larsson et al., 2011). Group of subjects who more frequently ate fatty fish had a median value, minimum, and maximum levels

of HDL are higher than those in lean fish. This is consistent with research states that the intervention of fatty fish did not affect the levels of VLDL and LDL but affects the concentration and size of HDL (Erkkila *et al.*, 2014). However, the results of other studies have also pointed out that PUFA is not as effective as MUFA in increasing levels of HDL (Bogl *et al.*, 2013). The type of fish is very necessary when checking the desired health effects of (n-3) PUFA derived from fish consumption, because not all types of fish contained PUFA omega-3 sufficiently (Chung *et al.*, 2008; Huynh and Kitts, 2009).

The results showed no statistically significant difference in lipid profiles of the two groups cooking methods based on comparative analytic Mann Whitney test, both in levels of triglycerides, total cholesterol, LDL-cholesterol and HDL-cholesterol. This can be explained that subjects was healthy young adults, in age range of 20-40 years, so they still have a metabolic efficiency, particularly in plasma lipid metabolism, either by eating fish with recommended methods processing or not recommended. This condition is the same as the results of research Bogl *et al.* (2012) stating that no significant differences in the lipid profile between subjects with fish consumption habits and they were not, because all subjects were healthy young adults aged 20-25 years. At age <30 years and the physiological of body metabolism is still efficient. Several studies including De Castro *et al.* (2007) state that no variation of PUFA omega-3 content in a variety of cooking methods included frying.

He *et al.* (2008) in his research proved the existence of a significant relationship between nonfried fish consumption with decreased levels of triglycerides and increased HDL levels, while it does not happen to fried fish. Several studies, including Candela *et al.* (1998) stated that fried fish is not a good source of PUFA omega-3 because during the frying process many changes in nutrient content, especially unsaturated fatty acid profile in fish, absorbing PUFA omega-6 from cooking oil and frying in hydrogenated vegetable oil incorporated trans fatty acids. Several studies of cardiovascular outcomes distinguish between groups of fried fish and nonfried fish, proving that fish nonfried group associated with a lower risk of cardiovascular events, while the fried fish is not (Mozaffarian *et al.*, 2003; Mozaffarian *et al.*, 2004; Mozaffarian, Longstreth, Lemaitre *et al.*, 2005; Mozaffarian Bryson, Lemaitre *et al.*, 2005). Cooking methods become important because many studies prove that relationship is precisely proportional between fish consumption habits and higher triglyceride levels was due to the

method of cooking was by fried. Marine fish contain a lot of polyunsaturated fatty acids when subjected to high heat frying especially, will turn its contents into trans fatty acids and saturated fatty acids. Both of them actually provide greater opportunities for atherosclerosis (Lai *et al.*, 2013).

The other way, De Castro *et al.* (2007) reported that the fatty acid composition was not significantly different during storage and cooking preparation. Cooking methods were not affect the composition of fatty acids in the fish. Some types of fish are analyzed in a state of raw, roasted and steamed, did not demonstrate a significant difference in the fatty acid content. Larsen *et al.* (2010) also said that the results of research comparing various methods of cooking with the content of the raw fish. Raw, poached, steamed, microwaved, no added oil pan fried, oven baked and no added oil is only showing little difference in the fatty acid content, but the result of deep fried indicate the lowest in PUFA omega-3 content.

In general, based on the foregoing discussion, the method of cooking fish that is widely used by people in Kendari can still provide a beneficial effect, especially to reduce the risk of CVD events, when the method is deep frying at temperatures 175°C-180°C and in a relatively short time of ± 5 minutes for each side of the fish (De Castro *et al.*, 2007; Larsen *et al.*, 2010; Neff *et al.*, 2014). Do not use waste oil (jelantah) because it has been hydrogenated and contains a lot of free radicals. It would be better if use oils high in omega-6 such as canola oil. In Indonesia, most of people use palm oil to fry, or coconut oil in some special moment. But keep in mind, palm oil and coconut oil is high in saturated fat. American Heart Association (2014) and Neff *et al.* (2014) suggest to use the recommended methods (baking, broiling, steaming) in cooking fish, to maintain the content of omega-3 PUFA and to obtain other beneficial effects.

Nevertheless, frying was a method which preferred by most of people because besides the fish will be easy to digest, it also increases the value of sensory. The fish were cooked by frying will more tasty and crunchy, compared with other cooking methods. Frying with canola oil will increase the ratio of omega-3 and omega-6, while frying using soybean oil can increase the content of PUFA in general, but frying in vegetable oil was hydrogenated incorporated trans fatty acids in the fillets (Weber *et al.*, 2007). Based on the result of this research, frying the fish using palm oil did not diminish PUFA omega-3 content, proved no difference in plasma lipid levels between the subjects who consuming fried fish and nonfried fish.

Conclusion

Different fish cooking method do not affect the beneficial effect of fish consumption in reduction of risk of atherosclerosis. Total fish intake is more dominant than cooking method to affect the plasma lipid levels. Consuming fried fish by deep frying in a proper time and temperature, and not using hydrogenated oil may give beneficial effect on plasma lipid. Sometimes frying method may give a beneficial effect for health dependent to the temperature was using, oil, and other materials were added for example flour for layered.

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