Effects of Rice Bran Oil Administration on Lipid Profiles of Hypercholesterolemic Junior high school Teachers

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Abstract

Background: Rice Bran Oil (RBO) Rice bran oil is an abundant food source in Indonesia and contains high levels of monounsaturated fatty acids and is rich in antioxidants. However, clinical trials on this material are still very limited.

Objective: This research aims to assess the differences of effect of rice bran oil (RBO) and olive oil (OO) administration on lipid profile alteration of hypercholesterolemic junior high school teachers.

Methods: This study used a quasi-experimental method with a non-randomized pre-test and post-test design with a control group. A total of 28 junior high school teachers in the Tamalanrea District of Makassar City who experienced hypercholesterolemia were recruited in this study and were divided into 2 groups. The two groups were at different research locations and received different interventions. Both groups received the same education. The intervention group was given rice bran oil (30 ml/day) while the control group was given olive oil (30 ml/day). Each group underwent treatment for 30 days. Before and after the intervention was given, researchers measured the lipid profile which included total cholesterol, HDL, LDL, and triglycerides. In addition, an anthropometric assessment of consumption and nutritional status was also carried out at the beginning and end of the study. The pair t test was used to determine the difference in effects before and after giving RBO and OO. The analysis was continued by comparing the results in the two groups using the independent t test. The level of confidence was set at 95% with a significance value less than 0.05 (p <0.05).

Results: The majority of respondents involved in this study were women (89.3%) with a mean age between 50-52 years and undergraduate education level (67.9%). Based on anthropometric measurements, the average abdominal circumference of the respondents ranged from 83-90 cm and the average BMI was in the range 26-27 kg/m. The results of measurements of lipid profile, nutritional status, intake, and characteristics of respondents at the beginning of the study showed that the results were not significantly different (homogeneous), except for abdominal circumference. After giving RBO for 30 days, the results were a decrease in total cholesterol by 4.59%, triglycerides by 15.8%, LDL by 4.87%, but HDL levels also decreased, although in insignificant amounts (3.41%). Meanwhile, giving OO as a control reduced total cholesterol by 5.04% and triglycerides by 28.2%. In addition, there was also a slight increase in HDL levels by 0.45%, in contrast to LDL levels which did not show any difference at all. At the end of the study of the four lipid profile parameters observed, significant improvements were observed in the reduction of total cholesterol and triglyceride levels significantly after administration of RBO and OO (p <0.05). The results also showed that there was no significant difference between RBO and OO on changes in lipid profile (p> 0.05).

Conclusion: Rice bran oil and olive oil have the same effect in improving lipid profiles by significantly lowering total cholesterol and triglyceride levels.

Keywords: Hypercholesterolemia, lipid profile, nutritional education, olive oil, rice bran oil

Introduction

Cardiovascular disease (CVD) caused by heart and blood vessel disorders is still the leading cause of death globally. An estimated 17.7 million people die from cardiovascular disease each year. This figure represents 31% of all deaths in the world.[1] In developing countries, the risk of death from cardiovascular disease shows an increasing trend, including

in Indonesia.[2] The Association of Indonesian Cardiovascular Specialists (PERKI) in 2019 reported that cardiovascular disease is the main and first cause of all deaths, which amounted to 26.4%.[3] This is in line with data from the Basic Health Research (Riskesdas) in 2018, the incidence of heart and blood vessel disease has increased from year to year. At least, 15 out of 1000 people, or about 2,784,064 individuals in Indonesia suffer from heart disease.[4]

Unhealthy lifestyle, particularly dietary habits, is believed to play an important role in the development of heart disease. Several epidemiological studies have investigated the association between fat intake and cardiovascular disease.[5] A high-fat diet tends to lead to hypercholesterolemia, a risk factor associated with an increased incidence of cardiovascular disease. This can be identified by increasing levels of total cholesterol, low density lipoprotein (LDL), and triglycerides in the blood which are not balanced with an increase in high density lipoprotein (HDL).[6] Based on data from the Makassar City Health Office, it can be concluded that there is an increase in the number of hypercholesterolemia and hypertriglyceridemia 2017-2018 period from 40.13% to 43.70%. In aggregate, in Tamalanrea District there are 237 men and 247 women who suffer from hypercholesterolemia, referring to the Posbindu data collected by Puskesmas Antara.[7]

The lipid profile can be improved by changing diet that tends to be high in saturated fatty acids (SFA) to a diet based on mono- and polyunsaturated fatty acids (MUFA and PUFA).[8] Olive oil (OO) is a source of unsaturated fatty acids which has been shown to protect against the development of cardiovascular disease due to its protective bioactive properties.[9] Various studies have shown that OO consumption may improve lipid profiles by reducing blood lipid levels (cholesterol and triglycerides), binding oxidized LDL, and increasing HDL levels significantly.[10-12]

The use of olive oil (OO) in food is sometimes unsuccessful because the material will be degraded by heat so that it can reduce its biological function.[13] Rice bran oil (RBO) actually shows better heat stability because it has a high boiling point reaching 2540C, which higher than other vegetable oils including OO.[14] As a source of unsaturated fatty acids, RBO can be considered as a food substitute for OO. With better heat resistance, RBO can be processed into a wider range of food derivatives. Moreover, rice bran as a raw material for making RBO is abundantly available in Indonesia at a relatively affordable price. Utilization of RBO is also expected to have the same effect on improving lipid profiles. Moreover, RBO contains high levels of gamma-oryzanol which has been shown to help reduce blood fat levels and oxidative stress.[15] This study aims to determine the effect of RBO on lipid profiles,

including total cholesterol, HDL, LDL, and triglycerides in hypercholesterolemic junior high school teachers.

Material and Methods

Research Location and Design

This research was conducted at state junior high schools in the Tamalanrea District of Makassar City. There are 3 state junior high schools in the area and all of them are used as research locations. This type of research is a quasi-experimental with non randomized pre test post test design with control group. There were 2 groups in this study, including the intervention group who was given rice bran oil 30 ml/day for 30 days and the control group who was given 30 ml/day olive oil for 30 days. The dose is divided in half (15 ml) and applied to food at breakfast and the remainder given at dinner. This research was conducted in a single blind manner, where the researcher knew the group that was given rice bran oil and olive oil, while the study sample did not know whether the oil consumed was rice bran oil or olive oil.

Apart from giving RBO and OO, respondents also received dietary education at the beginning of the study discussing hypercholesterolemia and the benefits of rice bran oil and olive oil. This is expected to motivate respondents to comply with the interventions that will be given. To evaluate the compliance of respondents, RBO and OO were not given at the same time for 1 month's needs, but only 1 bottle (210 ml) was given for 1 week's needs. Every weekend, each respondent will be met again to receive the next 1 bottle of RBO and OO, while ensuring that the RBO and OO given previously have been consumed. Each respondent was also given a compliance record or control card and it was emphasized that it was only filled in when consuming RBO or OO within the specified amount and time. The control card will also be evaluated every weekend.

Study Population

The population in this study were all junior high school teachers in Tamalanrea District, Makassar City who were over 25 years of age, had total cholesterol levels of more than 200 mg / dL and were willing to consume rice bran oil (RBO) or olive oil (OO) for 30 days. The total population obtained was 116 people. Subjects who met the inclusion criteria were then examined for medical history, medication, physiological conditions, and certain habits that could lead to biased study results. Study subjects who were pregnant or breastfeeding, smoking, undergoing steroid therapy, taking lipid-lowering drugs, and having a history of nephropathy, cardiovascular disease, diabetes, and other chronic diseases were

not included in this study. Other external variables such as physical activity were considered homogeneous considering the research subjects had the same profession and working hours, while other characteristics including gender, age, education, abdominal circumference, and BMI were included in this study.

Sampling

The sample in this study were junior high school teachers with hypercholesterolemia. The calculation of the sample size is based on the research of Hasan, et al (2013) regarding the effect of olive oil on the lipid profile levels of hyperlipidemic patients with the following formulations:

$$n1 = n2 = 2\left[\frac{[Z_\alpha + Z_\beta]s}{X_1 - X_2}\right]^2$$

After calculating the sample size, the number of samples needed in this study was 13 people for each group. To anticipate dropouts in the middle of the research, an additional 20% was made. A total of 32 people were involved in this study and were divided into 2 groups, including the intervention group and the control group. At the end of the study, 3 people were excluded because they did not consume rice bran oil or olive oil for 2 consecutive days or had accumulated 7 days during the study period. Meanwhile, in the data analysis, 1 person was identified as having a fairly extreme total cholesterol value and was considered an outlier so that he was not included in the data analysis. Thus there are 28 people who are the subjects in this study.

Data Collection

Initial data were obtained by measuring the cholesterol levels of junior high school teachers in Tamalanrea District, Makassar City to determine hypercholesterolemic status. Furthermore, the selected study subjects were assessed for their lipid profiles including total cholesterol, triglycerides, HDL, and LDL which were carried out at the beginning and end of the study. Blood specimen collection and lipid profile examination were carried out at the Clinical Health Laboratory. In addition, a consumption survey was also conducted using the 24-hour food recall method as well as an assessment of nutritional status including anthropometric abdominal circumference and BMI. Respondent characteristic data were obtained through interviews, supplemented with secondary data from the profile of each school.

Ethical Consideration

This study has been approved and obtained permission by the Health Research Ethics Committee of the Faculty of Public Health of Hasanuddin University under protocol number 21019042143.

Data Analysis

Statistical analysis was performed univariate and bivariate using the STATA® programs. Univariate analysis was performed using the frequency distribution for each categorical variable. The frequency distribution aims to describe the characteristics of the respondents which include gender, age, education, abdominal circumference, and BMI. In addition, an intake level assessment was also carried out which included energy, protein, fat, carbohydrates, fiber, SFA, MUFA, and PUFA. To observe the differences in the characteristics and intake of respondents at the beginning of the study, the Fisher Exact and Independent t test were used. Bivariate analysis using paired t test was performed to see the effect of RBO treatment in the intervention group and OO in the control group on changes in lipid profiles. Furthermore, a different test using the Independent t test was performed to describe the differences in lipid profiles between the RBO and OO groups at the end of the study.

Results

Respondents in this study were teachers of state junior high schools in the Tamalanrea District of Makassar City who had hypercholesterolemia. A total of 32 research subjects were included in this study and were divided into the intervention group and the control group. At the end of the study, 3 of them were excluded because they did not comply with the intervention instructions given. Respondents did not consume rice bran oil or olive oil for 2 consecutive days or had an accumulation of 7 days during the study period. Meanwhile, in the data analysis, it was identified that 1 person has a total cholesterol value that is quite extreme and is considered an outlier so that he is not included in the data analysis. Characteristics of respondents including gender, age, education level, and nutritional status based on BMI at the start of the study in the two groups did not show any significant difference ($p > 0.05$). The significant difference was only indicated by the abdominal circumference variable, where the mean abdominal circumference in the RBO group was higher than the mean abdominal circumference in the OO group. This means that the overall distribution of study subjects in the RBO and OO groups is quite homogeneous (Table 1).

Table 1: Characteristics and Nutritional Status of Respondents

Variables	Study Group		Sig (p)
	RBO (n=15)	OO (n=13)	

Gender (n, %)			
Male	1 (6.7)	2 (1.4)	1.000[a]
Female	14 (93.3)	11 (84.6)	
Age (mean ± SD)	50.9 (9.35)	52.8 (6.27)	0.554[b]
Educational level (n, %)			
S1	10 (66.7)	9 (69.2)	0.228[a]
S2	5 (33.3)	4 (30.8)	
Abdominal circumference (mean ± SD)	90.4 (8.14)	83.2 (9.19)	0.037[b]
BMI (mean ± SD)	27.4 (3.59)	26 (1.46)	0.201[b]

Abbreviations:

n = number of respondents, n (%) = number and percentage of respondents on study variable

mean ± SD = mean value and standard deviation of respondents on research variables, Sig (p) = significance value $p<0,05$

[a] Fisher Exact analysis results between groups in the same column

[b] Independent t test analysis result between groups in the same column

A total of 28 teachers participated in this study which were dominated by women (89.3%) with an average age range of 50-52 years. There were 19 respondents who had completed undergraduate education and even 9 (32.1%) of them had taken their master's degree. This is expected to support adherence to the education provided at the beginning of the study. Hypercholesterolemic status which became the inclusion criterion in this study was corroborated by the nutritional status of the respondents which was more viewed from the abdominal circumference parameters that had exceeded the 80 cm cut-off point for women and BMI with a mean of 26-27.

Respondents who participated in this study were assessed for their consumption description using a 24-hour food recall questionnaire. This assessment was carried out at the beginning and end of the study. The collected food ingredients were analyzed using the Nutrisurvey programs and the results are presented in Table 2.

Table 2: Hypercholesterolemic Junior High School Teacher Intake at the Beginning of the Research

Intake Categories	Study Group		Total	Sig (p)*

	RBO		OO				
	n (n=15)	%	n (n=13)	%	n	%	
Energy (1800 kcal)							1,000
Low (<80%)	7	46.7	9	69.2	16	57.1	
Adequate (80%-110%)	6	40	4	30.8	10	35.7	
High (>110%)	2	13.3	0	0	2	7.1	
Protein (90 grams)							1,000
Low (<80%)	13	86.7	12	92.3	25	89.3	
Adequate (80%-110%)	1	6.7	1	7.7	2	7.1	
High (>110%)	1	6.7	0	0	1	3.6	
Fat (50 grams)							0,538
Low (<80%)	3	20	6	46.2	9	32.1	
Adequate (80%-110%)	1	6.7	3	23.1	4	14.3	
High (>110%)	11	73.3	4	30.8	15	53.6	
Carbohydrate (247,5 grams)	10	66.7	7	53.8	17	60.7	0,755
Low (<80%)	4	26.7	6	46.2	10	35.7	
Adequate (80%-110%)	1	6.7	0	0	1	3.6	
High (>110%)							
Fiber (25 grams)							-
Low (<25 grams)	14	93.3	13	100	27	96.4	
Adequate (≥25 grams)	1	6.7	0	0	1	3.6	
SFA (<7% x 1800 kkal)							1,000
Adequate	10	66.7	8	61.5	18	64.3	
High	5	33.3	5	38.5	10	35.7	
PUFA (>10% x 1800 kkal)							1,000
Low	8	53.3	11	84.6	19	67.9	
Adequate	7	46.7	2	15.4	9	32.1	
MUFA (>20% x 1800 kkal)	15	100	13	100	28	100	-
Low	0	0	0	0	0	0	
Adequate							

Abbreviations:

SFA = Saturated Fatty Acid, PUFA = Polyunsaturated Fatty Acid, MUFA = Monounsaturated Fatty Acid, n(%) = number and percentage of intake of respondents on each category, Sig (p) = Significance value p<0,05

* Fisher Exact analysis results between groups in the same column

Table 2 shows no significant differences in consumption between the intervention and control groups. Most of the consumption of macronutrients is in the low category, except for fat consumption where half of the respondents consume more than 110% (53.6%). This tendency can be an early predictor of hypercholesterolemic conditions experienced by respondents. The low consumption of fiber can also strengthen this assumption, among the 28 research subjects involved in this study only 1 person consumed fiber according to the recommended adequacy rate (96.4%). In line with that, a saturated fat-based diet (SFA) that exceeds 10% of total calories is still shown by at least 35.7% of respondents. On the other hand, there is a tendency to consume a very limited amount of unsaturated fatty acid sources, even if none of the respondents meet the recommended sufficient amount for MUFAs.

At the end of the study, the survey was repeated to see differences in mean consumption before and after the intervention in the two groups. This can provide an overview of the trend in nutrient consumption that is directly associated with changes in lipid profiles, especially energy, carbohydrates, fiber, fat and fatty acids (SFA, PUFA, MUFA) as shown in Table 3.

Table 3: Difference in Average Consumption After Rice Bran Oil and Olive Oil Administration to Diet

Study Group	Intake		Δ mean[a]	Sig (p)[b]
	Before mean±SD	After mean±SD		
Energy (kcal)				
RBO	1606.24±571.51	1668.4±94.28	-62.16±549.50	0.067
OO	1382.46±221.41	1668.17±37.41	-285.72±140.54	0.000
Sig (p)[c]	0.20	0.99	0.17	
Protein (gr)				
RBO	57.05±20.10	51.41±9.15	5.63±23.30	0.365
OO	51.07±11.68	50.45±11.59	0.62±15.54	0.887
Sig (p)[c]	0.36	0.81	0.52	

Fat (gr)				
RBO	65.01±25.42	69.26±15.52	-4.25±26.04	0.537
OO	45.54±19.42	67.36±12.03	-21.82±16.32	0.000
Sig (p)^c	0.03	0.72	0.04	
Carbohydrate (gr)				
RBO	194.6±94.19	207.58±37.7	-12.98±80.43	0.542
OO	193.05±35.06	215.18±26.67	-22.12±46.81	0.114
Sig (p)^c	0.96	0.55	0.72	
Fiber (gr)				
RBO	8.23±7.19	10.99±6.86	-2.76±3.71	0.012
OO	8.2±3.05	10.69±2.50	-2.49±4.66	0.078
Sig (p)^c	0.99	0.88	0.87	
SFA (gr)				
RBO	22.27±11.9	19.73±8.18	2.53±14.04	0.496
OO	18.69±7.91	19.77±7.22	-1.08±6.6	0.567
Sig (p)^c	0.37	0.99	0.38	
PUFA (mg)				
RBO	20.27±13.31	20.87±6.17	-0.6±12.40	0.854
OO	11.31±8.94	10.08±4.17	1.23±10.26	0.673
Sig (p)^c	0.02	0.00	0.68	
MUFA (mg)				
RBO	14.53±5.96	22.67±3.74	-8.13±6.81	0.000
OO	13.31±7.06	32.46±3.78	-19.15±5.77	0.000
Sig (p)^c	0.62	0.00	0.0001	

Notes:

Data expressed as mean±SD, significance value p<0,05

SFA = Saturated Fatty Acid, PUFA = Polyunsaturated Fatty Acid, MUFA = Monounsaturated Fatty Acid

[a] Difference between post-test and pre-test means

[b] Paired t test analysis results between groups in the same column

[c] Independent t test analysis results between groups in the same column

At the end of the study, the intervention in the form of RBO, OO and education gave positive results. This can be observed with an increase in the consumption of energy, carbohydrates, fiber, and MUFA. However, significant results were only obtained on the increase in the mean energy consumption in the OO and MUFA groups in both groups. The existence of a significant difference in MUFA consumption when compared to the intake assessment at the start of the study suggests a direct contribution to the provision of RBO and OO. The increase in consumption of MUFA sources is also expected to reduce the negative effects arising from the consumption of total fat which has been indicated by the majority of respondents since the beginning of the study.

The recommended total fat consumption in this study is 50 g / day. At the start of the study, actually the excess fat consumption in the OO group only showed a percentage of about 30% with an average intake of 45.54 grams. This is different from the RBO group, which since the beginning has shown an excess proportion of fat intake with an average of up to 65 grams. However, consistent results were not obtained for the OO group's fat intake, the intake assessment at the end of the study showed a mean increase of 21.8 g and had exceeded the mean fat intake in the RBO group. These results lead to differences in mean fat consumption in the two groups at the start of the study and the mean increase in consumption after the second intake assessment at the end of the study.

The difference in intake between the two groups was also shown in the consumption of fatty acids, including PUFA and MUFA. Since the beginning of the study, PUFA consumption in the RBO group showed a half higher mean intake than the OO group. Conversely, MUFA consumption showed a very good mean increase in the OO group after the intervention was carried out with increases reaching 19 mg. This average increase exceeds the increase in MUFA consumption in the RBO group which only reached 8.13 mg.

To assess the contribution of the increase in MUFA identified through the consumption assessment, a lipid profile was measured. Table 4 presents the differences in total cholesterol, HDL, LDL, and triglyceride levels after the addition of RBO and OO in the diet of respondents with controlled amounts and time periods.

Table 4: Comparison of Lipid Profiles Before and After Rice Bran Oil and Olive Oil Administration

Study Group	Lipid Profiles (mg/dL)		Δ mean[a]	Sig (p)[b]
	Before	After		

	mean±SD	mean±SD		
Total Cholesterol		242.07±36.85	11.67±20.85	0.047
RBO	253.73±46.83			
OO	241.15±28.54	229±22.47	12.15±16.10	0.014
Sig (p)[c]	0.41	0.28	0.95	
HDL				
RBO	50.67±9.53	48.93±9.12	1.73±4.08	0.122
OO	51±10.33	51.23±8.31	-0.23±6.49	0.900
Sig (p)[c]	0.93	0.49	0.34	
LDL				
RBO	183.47±43.42	174.53±35.58	8.93±26.17	0.207
OO	154.31±46.15	154.31±30.15	0±24.3	1.000
Sig (p)[c]	0.09	0.12	0.36	
Triglycerides				
RBO	197.53±65.35	166.27±49.15	31.27±44.56	0.016
OO	232.77±167.9	167.08±72.23	65.69±108.04	0.049
Sig (p)[c]	0,46	0.97	0.27	

Notes:

Data is expressed as mean±SD, significance value $p<0,05$

[a]Difference between post-test and pre-test means

[b]Paired t test analysis results between groups in the same column

[c]Independent t test analysis results between groups in the same column

Rice bran oil and olive oil showed an equally significant contribution in reducing total cholesterol and triglyceride levels. Although it has the same effect in both parameters, it turns out that RBO and OO show different results in HDL and LDL parameters. In the RBO group there was a decrease in HDL levels, while in the OO group there was a slight, insignificant increase. Meanwhile, in the LDL parameter, the RBO group showed a better reduction, when compared to the OO group, which had no difference in the mean at all before and after being added to the diet. Figure 1 below visualizes the changes that occurred in the control and intervention groups.
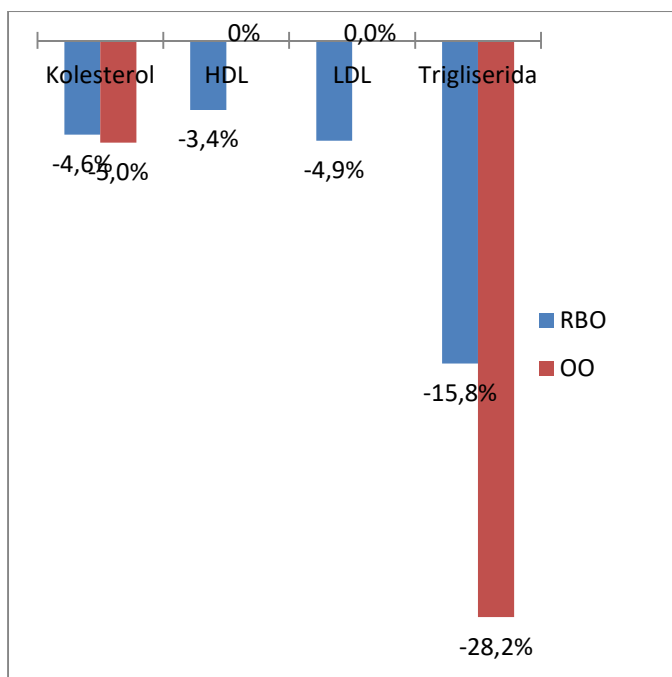
Figure 1: Percentage Change in Lipid Profile

By re-observing Tables 1 and 2, it can be concluded that at the start of the study there were no statistical differences in characteristics, nutritional status, and intake between the RBO and OO groups, except in the parameters of the abdominal circumference. In almost the same conditions, OO showed a better percentage in lowering triglycerides and cholesterol and increasing HDL levels by 0.45%. On the other hand, the RBO group showed a better decrease in LDL levels, but at the same time it was also followed by a decrease in HDL levels reaching 3.4%.

Discussion

Functional food ingredients that can be used to control and lower blood cholesterol levels are rice bran oil and olive oil.[16] The main components of both are monounsaturated fatty acids (MUFA) and other functional bioactive ingredients including tocopherols , carotenoids, phospholipids and phenols.[17] These contents have a positive contribution to the improvement of lipid profiles by reducing cholesterol and triglyceride concentrations.[18] This is in line with the results obtained that both RBO and OO show significant results in lowering cholesterol and triglyceride levels.

The effect of RBO and OO in reducing cholesterol and triglyceride levels can be observed from the results of the intake assessment. The mean amount of MUFA consumed increased significantly in both groups when compared to consumption at the start of the study. It's just that the increase in MUFA consumption is not balanced with an increase in fiber intake and other sources of unsaturated fatty acids. This underlies the absence of

significant significance found in HDL and LDL parameters. In fact, the two groups showed different patterns and trends in giving effect to HDL and LDL levels. In the group given RBO, there was a decrease in LDL, but at the same time it also decreased HDL. On the other hand, in the OO group, it can be observed that there is an increase in HDL levels in a small percentage, but it does not show a decrease in LDL levels. A study conducted on migrant workers in China proved a correlation between an increase in fiber intake (> 30 g/day) with an increase in HDL concentration up to 10% accompanied by a decrease in the total-LDL cholesterol ratio reaching 14% .[19]

In contrast to fiber, previous studies have shown that unsaturated fats have a neutral effect on LDL cholesterol concentrations.[18] This means that to optimize the effect of reducing HDL and LDL levels, it must also be accompanied by adequate fiber consumption. The tight working hours are suspected to be the cause of the not optimal dietary education provided. Most of the responses are constrained in preparing breakfast at home, meanwhile school canteens do not provide a variety of foods with proper processing to maintain nutrient content. School canteens generally only sell snacks with soup and fried foods with a very low percentage of vegetables and fruit. This also indicates that the energy needs of 1800 kcal have not been fulfilled as recommended, on the other hand, the intake of fat has actually increased. At the start of the study, it was found that half of the respondents (53.6%) had fat consumption above 110%. These results were consistently found at the end of the study where the fat intake in both groups exceeded the recommended intake by the mean range of 67-69 g. Increased consumption of fat in the diet can be an indication of an increase in the amount of saturated and trans fat which can lead to an increase in total and LDL cholesterol.[20] This can have an inhibitory effect on improving lipid profiles by administering RBO and OO.

Inadequate carbohydrate consumption also affects the inadequate improvement in the overall lipid profile. Even though there was an increase in carbohydrate intake in the intervention and control groups at the end of the study, the average consumption did not meet the recommended needs of 247.5 gr. Carbohydrate diets are neutral to LDL cholesterol, so carbohydrate-rich foods are a good choice to replace a saturated fat diet. On the other hand, a diet rich in carbohydrates (<60% of total calories) is associated with increased HDL cholesterol concentrations and decreased triglyceride concentrations.[18]

The use of RBO and OO is not limited to proper diet modification, but also requires standard reference regarding the correct dosage. Rice bran oil applied in this study has a serving size of 15 ml with a frequency of 2 times a day (30 ml/day) with a MUFA content of

5.6 grams per serving. In one study it was recommended to consume 50 grams of RBO daily to achieve a beneficial effect in reducing the risk of chronic disease.[21] In another study involving women with hypercholesterolemic conditions aged 19-55 years found that consuming 45 ml/day of RBO gave better results in improving lipid profile compared to consuming only RBO 15 ml/day.[22] In this study, the determination of RBO dosage referred to the study of Zavoshi, et. al. (2012) for adults aged 25-65 years as much as 30 ml/day. While the dosage for OO is based on the research of Hasan et. al. (2013) against adults aged 40-55 years with a dose of 30 ml/day.[12,23]

The absence of consensus regarding the dosage of RBO and OO requires further research. This dosage is very important in diet therapy aimed at hypercholesterolemic individuals in the 46-55 year age group. The characteristics of respondents identified in this study indicate that most of the hypercholesterolemic condition is at the productive age in that age range. This is confirmed by a study in Poland which found more than half of the adult population suffering from hypercholesterolemia with the highest percentage found in the 46-55 year old group (91.9%).[24]

Another characteristic of respondents that is considered influencing the lipid profile parameters measured in this study is the anthropometric index. In order to assess the true effect of RBO and OO interventions, the BMI and abdominal circumference variables must be considered. The follow-up process and the short study duration had not found any improvement in BMI and abdominal circumference at the end of the study. While it is believed that BMI and abdominal circumference that exceed the normal threshold show a significant association with an increased risk of hypercholesterolemia, hypertriglyceridemia, and decreased HDL concentration.[25] In line with these results, Listiyana's (2013) study concluded that there is a relationship between central obesity and cholesterol levels in women aged 45-54 years in Plalangan Village, Gunungpati District, Semarang City.[26] In this study, respondents had more nutritional status referring to the BMI average which was 26-27, evenly distributed in the control and intervention groups. Meanwhile, based on abdominal circumference parameters, the OO group had a lower mean and was significantly different from the mean abdominal circumference in the RBO group. This could be one reason for the difference in effect found in the increase in HDL levels between the two groups, where the OO group showed a better percentage increase in HDL levels. Even so, the increase in HDL levels observed in the OO group did not meet any significance, the percentage increase only reached 0.45%. The short duration of the study has the potential to cause the observed

intervention effect to be not optimal. Animal studies have shown that it will take at least 8 weeks to see significant results on lipid profiles after administration of RBO and OO.[27]

The final result obtained from this study is the comparison of RBO and OO in improving lipid profile. Statistically, there was no difference in the effect of the two groups on the measured lipid profile. However, if examined more deeply, OO showed a better percentage in lowering triglycerides and cholesterol and slightly raising HDL levels. In contrast, the RBO group showed a better decrease in LDL levels, but at the same time it was also followed by a decrease in HDL levels. The difference in the effects of RBO and OO is related to the differences in the content contained therein. Olive oil consists of the glycerol fraction (90-99%) and the non-glycerol fraction (0.4% -5%). The glycerol fraction consisted of 78% MUFA, 8% PUFA, and 12% SFA. Meanwhile, RBO contains 37% PUFA, 38% MUFA, and 25% SFA.[28] This is confirmed by the results of the analysis in Table 2, in the same amount MUFA in OO shows a greater average increase reaching 19.15 mg compared to the mean RBO. which is only 8.13 mg.

Although it is considered as a good source of unsaturated fat, OO has a disadvantage in its application in the diet due to its low smoke point. This weakness can be covered by RBO which has a very high boiling point of up to 254°C, which is the highest compared to other vegetable oils. From the results of this study, it was found that there was no significant difference between RBO and OO in improving lipid profile, this underlies the wider use of RBO. Rice bran oil can be processed into various derivative products such as cooking oil, supplement products, health, and cosmetics. In the health sector, current research seeks to strengthen the use of RBO as a safer alternative natural hypolipidemic agent than the drug atorvastatin which can cause side effects in some cases in statin-intolerant patients.[29]

Conclusion

Rice bran oil and olive oil administration to hypercholesterolemic junior high school teachers can significantly improve total cholesterol and triglycerides. Meanwhile, the effect on HDL and LDL improvement has not shown consistent results. Apart from the time duration and the number of doses to be administered, diet modification is also very necessary to optimize the effects of RBO and OO. The potential effects of RBO that are not much different from OO can be considered for the use of RBO into a broader derivative product. In Indonesia, easier access to RBO and a more economical price ensures certainty for its use as functional food.

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Conflict of Interest

The authors declared that there is no conflict of interest.

References

1. World Health Organization. Cardiovascular diseases (CVDs). Geneva: World Health Organization; 2017. Available from: https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds).

2. Maharani A., Sujarwoto, Praveen D., Oceandy D., Tampubolon G., Patel A. Cardiovascular Disease Risk Factor Prevalence and Estimated 10-Year Cardiovascular Risk Scores in Indonesia: The SMARThealth Extend Study. *PLoS ONE*. 2019; 14(4): e0215219. https://doi.org/10.1371/ journal.pone.0215219.

3. Perhimpunan Dokter Spesialis Kardiovaskular Indonesia (PERKI). Press Release Hari Jantung Sedunia (*World Heart Day*). Jakarta: PERKI; 2019. http://www.inaheart.org/news_and_events/news/2019/9/26/press_release_world_heart_day_perki_2019.

4. Badan Penelitian dan Pengembangan Kesehatan. Riset Kesehatan Dasar. Jakarta: Kementerian Kesehatan Republik Indonesia; 2018.

5. Zhu Y., Bo Y., Liu Y. Dietary Total Fat, Fatty Acids Intake, and Risk of Cardiovascular Disease: A Dose-Response Meta-Analysis of Cohort Studies. *Lipids Health Dis*. 2019; (18)91. https://doi.org/10.1186/s12944-019-1035-2.

6. Briggs M. A., Petersen K. S., Kris-Etherton P. M. Saturated Fatty Acids and Cardiovascular Disease: Replacements for Saturated Fat to Reduce Cardiovascular Risk. *Healthcare (Basel)*. 2017; 5(2):29. DOI:10.3390/healthcare5020029.

7. Dinas Kesehatan Kota Makassar. Laporan Bidang Pengendalian dan Pemberantasan Penyakit Tahun 2017 dan Tahun 2018. Makassar: Dinkes Kota Makassar; 2018.

8. Harris C. P., von Berg A., Berdel D., Bauer C. P., Schikowski T., Koletzko S., Heinrich J., Schulz H., Standl M. Association of Dietary Fatty Acids with Blood Lipids is

Modified by Physical Activity in Adolescents: Results from the GINIplus and LISA Birth Cohort Studies. *Nutrients*. 2018; 10(10):1372. https://doi.org/10.3390/nu10101372.

9. Mart´ın P. S., Covas M. I., Fito´ M., Kusˇar A., Pravst I. Health Effects of Olive Oil Polyphenols: Recent Advancesand Possibilities for The Use of Health Claims. *Mol. Nutr. Food Res*. 2013; 57:760–771. DOI 10.1002/mnfr.201200421.

10. Namayandeh S. M., Kaseb F., Lesan S. Olive and Sesame Oil Effect on Lipid Profile in Hypercholesterolemic Patients, Which Better?. *Int J Prev Med*. 2013; 4(9):1059-1062.

11. Raventos, Lamuela R. M., Gimeno E., Fitó M., Castellote A. I., Covas M., Torre-Boronat M. C. D. L., López-Sabater M. C. Interaction of Olive Oil Phenol Antioxidant Components with Low Density Lipoprotein. *Biol Res*. 2004; 37:247-52.

12. Neyaz H. S., Singh D., Siddiqui S. S., Kulshreshtha M., Aggarwal T. Effects of Olive Oil on Lipid Profile in Hyperlipidaemic Patients. *J. Med. Res*. 2013; 3(4).

13. Giuffrè A. M., Zappia C., Capocasale M. Effects of High Temperatures and Duration of Heating on Olive Oil Properties for Food Use and Biodiesel Production. *J Am Oil Chem Soc*. 2017; 94:819–830. DOI 10.1007/s11746-017-2988-9.

14. Hadipernata, Mulyana. Mengolah Dedak menjadi Minyak (Rice Bran Oil). Bogor: Dalam Warta Penelitian dan Pengembangan Pertanian. 2007; 29(4): 8–10.

15. Bumrungpert A., Chongsuwat R., Phosat C., Butacnum A. Rice Bran Oil Containing Gamma-Oryzanol Improves Lipid Profiles and Antioxidant Status in Hyperlipidemic Subjects: A Randomized Double-Blind Controlled Trial. *J Altern Complement Med Title*. 2019; 25(3). https://doi.org/10.1089/acm.2018.0212.

16. Tuarita M. Z., Sadek F. N., Sukarno, Yuliana N. D., Budijanto S. Pengembangan Bekatul sebagai Pangan Fungsional: Peluang, Hambatan, dan Tantangan. Bogor: Fakultas Teknologi Pertanian Institut Pertanian Bogor; 2016.

17. Ghanbari R., Anwar F., Alkharfy K. M., Gilani A. H., Saari N. Valuable Nutrients and Functional Bioactives in Different Parts of Olive (Olea europaea L.): *A Review. Int. J. Mol. Sci*. 2012; 13:3291-3340.

18. Perhimpunan Dokter Spesialis Kardiovaskular Indonesia (PERKI). Panduan Tata Laksana Dislipidemia. Jakarta: PERKI; 2017. Available from: http://jki.or.id.

19. Zhou Q., Wu J., Tang J., Wang J. J., Lu C. H., Wang P. X. Beneficial Effect of Higher Dietary Fiber Intake on Plasma HDL-C and TC/HDL-C Ratio among Chinese Rural-to-Urban Migrant Workers. *Int J Environ Res Public Health*. 2015; 12(5):4726-38. doi: 10.3390/ijerph120504726.

20. Houston D. K., Ding J., Lee J. S., Garcia M., Kanaya, A. M., Tylavsky F. A., Newman A. B., Visser M., Kritchevsky S. B. Dietary Fat and Cholesterol and Risk of Cardiovascular Disease in Older Adults: the Health ABC Study. *Nutr Metab Cardiovasc Dis*. 2011; 21(6):430-437. doi:10.1016/j.numecd.2009.11.007.

21. Ali A., Devarajan S. Nutritional and Health Benefits of Rice Bran Oil. in: Manickavasagan A., Santhakumar C., Venkatachalapathy N. (eds) Brown Rice. Springer; 2017.

22. Erlinawati N. D., Oetoro S., Gunarti D.R. Effect of Rice Bran Oil on the Lipid Profile of Mild-Moderate Hypercholesterolemic Male Aged 19-55 Year. *World Nutr. J*. 2017; 1(1). http://dx.doi.org/10.25220/WNJ.V01i1.0010.

23. Zavoshy R., Noroozi M., Jahanihashemi H. Effect of Low Calorie Diet with Rice Bran Oil on Cardiovascular Risk Factors in Hyperlipidemic Patients. *J Res Med Sci*. 2012; 17:626-31.

24. Hoffmann K., Matyjaszczyk P., Zaporowska S. I., Kostrzewska M., Piorunek T., Minczykowskp A., Bryl W. Lipid Profile of Polish Primary Care Patients Aged 35-55 Years Living in the District of Pleszew. *Acta Pol Pharm*. 2016; 73(2):537-46. PMID: 27180447.

25. Devi S., Choudhary A. K., Verma P., Jain N., Garg, N. Association of Lipid Profile, Body Mass Index, and Waist Circumference as Cardiovascular Risk Factors for Obese Male Adults of North India. *Int. J. Sci. Study*. 2017; 4(10):149-154. DOI: 10.17354/ijss/2017/30.

26. Listiyana A. D., Mardiana, Prameswari G. N. Obesitas Sentral dan Kadar Kolesterol Darah Total. *KEMAS*. 2013; 9(1):37-43. https://doi.org/10.15294/kemas.v9i1.2828.

27. Ojah K., Gogoi G., Chaliha M., Borah A. Hypolipidaemic Effect of Rice Bran Oil and Olive Oil in Hypercholesterolemic Rats. *Indian J Basic Appl Med Res*. 2017; 7(1):98-108.

28. Wijayanthie N., Gunarti D. R., Manikam N. R., Yulhasri. Effects of Extra Virgin Olive Oil Versus Rice Bran Oil on Glycemic Control in Patients with Type-2 Diabetes Mellitus. *Int J App Pharm*. 2019; 11(6). DOI: 10.22159/ijap.2019.v11s6.33540.

29. Shakib M. C., Gabrial S., Gabrial G. Rice Bran Oil Compared to Atorvastatin for Treatment of Dyslipidemia in Patients with Type 2 Diabetes. *OA Maced J Med Sci*. 2014; 2(1):95-102. http://dx.doi.org/10.3889/oamjms.2104.017.