Consumption of 5 Servings of Fruit and Vegetable and Lipid Profile Improvement on Overweight Adolescents: a Randomized Control Trial

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Abstract—Dyslipidemia is associated with obesity. High consumption of fruit and vegetable (FV) might promote the prevention of dyslipidemia. The aim of this study was to determine the effectiveness of 5 servings of FV to improve lipid profile on overweight adolescents. This study was an experimental study with a randomized controlled trial with a pretest-posttest control group design. The subjects were overweight adolescents with each of 17 persons for the treatment group and control group. Intervention given was the addition of 3 servings of fruit and 2 servings of vegetable (3F2V) a day for four weeks. Blood lipid profile changes were tested using ANOVA Repeated Measure test. Giving 3F2V for 4 weeks showed there was a significant decrease in total cholesterol by 15.29 mg/dl (p=0.00), LDL-c by 10.45 mg/dl (p=0.01) and there was not significantly decreased in triglycerides by 3.73 mg/dl (p=0.07). HDL-c showed reversed changes although not significantly decreased by 2.70 mg/dl (p=0.59). There was a weight loss of 0.28 kg (p=0.04).The addition of 3F2V for 4 weeks could lower total cholesterol, LDL-c,and triglycerides in overweight adolescents,but can't increase HDL-c.

Keyword: meniran, tannin, permanganometry, qualitative, antioxidants

1. INTRODUCTION

Dyslipidemias are abnormal amounts of lipid (hydrophobic fat molecules such as cholesterol and fatty acids) and/or lipoprotein in the blood. Levels of lipid and lipoprotein are results of genetic and environmental contributions (diet, activity) [1]. Dyslipidemia is linked to overweight and obesity. Moderately to severely elevated TG, normal to mildly elevated LDL-cholesterol (LDL-c), and reduced HDL-cholesterol (HDL-c), most commonly seen in obese adolescents. Approximately 35.9% Indonesian people (all aged 15 and over) have higher total cholesterol levels, 22.9% have lower HDL-c and 15.9% have higher LDL-c [2].

Lifestyle modification is the first line treatment for dyslipidemia. This includes regular physical activity and diet [1]. Limiting intake of refine carbohydrate is useful to prevent hypertriglyceridemia. Another alternative treatment in preventing the occurrence of dyslipidemia that is by increasing the intake of fruits and vegetables. FV consumption data according to Riskesdas (2013) for most of Indonesia's population (93.6%) is still in low category [2]. FV consumption levels are said to be sufficient if consuming vegetables and/or fruits at least 5 servings per day [3].

High intake of FV are associated with a decreased risk of dyslipidemia[4,5]. The mechanism

association between high intake of FV and lipid profile are reduced cholesterol and fatty acid absorption, increased fecal bile acid excretion, bacterial fermentation produces propionic acid than inhibits HMG-CoA reductase[4]. The results of hyperlipidemia and overweight men showed an apple consumption of 100 grams/day for 8 weeks to decrease VLDL and TG, but not significant to total cholesterol, and LDL [6]. Other research results in healthy adults showed consumption of kimchi (fermented vegetables) for 7 days as much as 210 g/day can lower total cholesterol [7].

The fact that has been revealed in some of these studies is that there is no fruit or vegetable that gives overall effect on the lipid profile. This may be due to the quantity and quality of nutritious substances such as polyphenols, lycopene and fibers presented in FV are not enough to provide the desired effect. Therefore, this study was conducted to determine the effectiveness of the consumption of 5 servings of FV on the improvement of lipid profile in overweight adolescents.

2. MATERIALS AND METHOD

This research was started from September 18 until October 26, 2015. The research began by doing initial screening in the form of weight and height measurement conducted in Nutritional Assessment Laboratory of Health Polytechnic of Ministry of Health Semarang. Weight (kg) and height (cm) were measured for determining Body Mass Index (BMI). Lipid profile examination conducted in Health Laboratory and Medical Device Testing Center of Central Java Province on 03 October 2017 for examination of initial lipid profile and dated on 04 November 2017 for examination of lipid profile after intervention. The research location for the preparation and processing of FV was in Food Technology Laboratory of Nutrition in Health Polytechnic of Ministry of Health Semarang. The study subjects were healthy adult age group of female with the following criteria: BMI ≥ 23 kg/m^2, aged ≥18-21 years old and did not consume blood cholesterol lowering drugs. The sample size of each group was 17 people plus as alternative 2 people, so that the total sample required in this research was 38 people.The research design was experimental study with randomized controlled trial using pretest posttest control group design. Independent variable in this research was given 5 (five) servings of FV. The 5 servings of FV was 3 servings of fruit and 2 servings of vegetable (3F2V) a day for four weeks. Dependent variables in this study were total cholesterol, LDL-c, HDL-c and triglycerides. Instruments used in this study included: questionnaires, blood lipid measuring tool used to measure total cholesterol, LDL-c, HDL-c and triglycerides levels, monitoring form for consumption of FV and food scales. The effectiveness of the consumption of 5 servings of FV on lipid profile was tested using ANOVA Repeated Measure Test on α=0.05.

3. RESULTS AND DISCUSSION

Based on the results of screening, the number of respondents who had BMI ≥ 23 kg/m^2 was as many as 65 people from 380 people of the population of nutrition students of Health Polytechnic of Ministry of Health Semarang. The number of population that met the criteria was as many as 45 people, while taken as the subject of research was as many as 40 people consisting of 20 treatment groups and control groups of 20 people selected randomly. During 4 weeks of intervention there were 4 people who resigned due to illness and 2 people for not being able to fully qualify as a research subject.

Subjects in this study were 30 female overweight adolescents and obesity and male as many as 4 people, aged between 17 to 20 years. The intervention provided was the addition of 3F2V daily for four weeks. The fruits consisted of red guava, apple, watermelon, plantain, banana, dragon fruit, avocado, mango, papaya, tomatoes, strawberries, pear and tangerine given in whole form or juice taking turns following the 7 day menu cycle. While the vegetables provided included: spinach, mustard greens, *kangkung,* cassava leaves, carrots, cabbage, *gambas*, cucumber, and papaya leaf.

Subject Characteristics

The average age of the research subjects in the treatment group is 18.35 years, while in the control group is 18.41 years. The mean BMI of the subjects in the treatment group is 26.5 kg/m^2, while in the control group is 26.89 kg/m^2. The result of 24 hour recall for two days period showed that the level of fat and carbohydrate intake in both groups was above the level of intake of the recommended needs. However, in the control group the level of intake was higher than the treatment group. While the intake of protein and fiber intake levels were still below the recommended needs, although the treatment group was still higher than the control group. The results of the analysis can be seen in Table 1.

Table 1. Characteristics of research subjects by age, BMI, energy, protein, fat, carbohydrates and fiber

Variable	Group	
	Treatment (n=17) (mean±SD)	**Control (n=17) (mean±SD)**
Age (years old)	18,35 ± 0,60	18,41 ± 0,71
IMT (kg/m^2)	26,45 ± 3,90	26,77 ± 3,07
Energy (% on DRI)	99,85 ± 7,20	101,76 ± 9,66
Protein (% on DRI)	94,39 ± 21,92	83,70 ± 16,40
Fat (% on DRI)	110,42 ± 48,48	117,21 ± 63,22
Carbohydrate (% on DRI)	103,48 ± 7,23	104,37 ± 6,79
Fiber (% on DRI)	67,20 ± 6,40	47,29 ± 15,94
Fruit consumption (serving/day)		
Before intervention	1,71 ± 0,84	1,71 ± 0,68
During intervention	3,06 ± 0,28	1,77 ± 0,66
Vegetable consumption (serving/day)		
Before intervention	1,24 ± 0,43	1,41 ± 0,61
During intervention	2,35 ± 0,78	1,59 ± 0,61

Physical activity of the subjects showed that most exercise habits were done only once a week in both treatment and control groups (76.47%). Based on the history of hypercholesterolemia in the family of the subjects, most of them had no family history of hypercholesterolemia with percentage in the treatment group (58.82%), while in the control group, most of them had family hypercholesterolemia (64.70%). Measurement results of the BMI indicated most of the subjects included in the category of obesity in the treatment group of 64.70% and the control group 76.47%. Based on vegetable consumption of 2 servings per day in the treatment group (82.35%), while in the control group consumed 1

serving per day (47.06%). Fruit consumption of the subjects was mostly 3 servings per day in the treatment group (94.12%), while in the control group consumed 2 servings per day (52.94%) as presented in table 2.

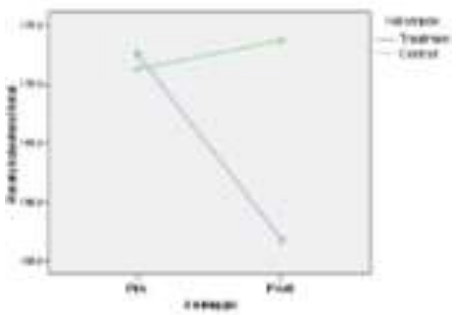
Table 2. Characteristics of subjects according to physical activity, history of dyslipidemia, nutritional status, consumption of FV

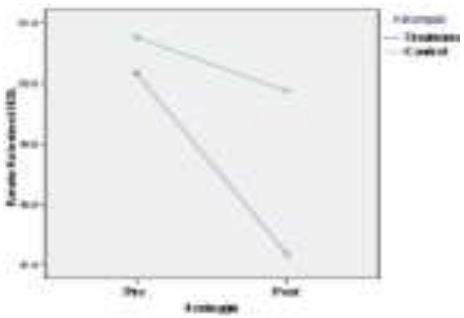
Variables	Group	
	Treatment (n=17) n (%)	**Control (n=17) n (%)**
Activity (per week)		
Once	13 (76,47)	13 (76,47)
Twice	4 (23,53)	4 (23,53)
Dyslipidemia History		
Yes	7 (41,17)	11 (64,70)
No	10 (58,82)	6 (35,30)
Nutritional Status Category		
Overweight	6 (35,30)	4 (23,53)
Obesity	11 (64,70)	13 (76,47)
Vegetable consumption (servings)		
1 serving	0 (0,00)	8 (47,06)
2 servings	14 (82,35)	8 (47,06)
3 servings	0 (0,00)	1 (5,88)
4 servings	3 (17,65)	0 (0,00)
Fruit consumption (servings)		
1 serving	0 (0,00)	6 (35,30)
2 servings	0 (0,00)	9 (52,94)
3 servings	16 (94,12)	2 (11,76)
4 servings	1 (5,88)	0 (0,00)

Table 2 shows that adding 3F2V daily for 4 weeks can significantly reduce total cholesterol, LDL-c and body weight. Giving 3F2V for 4 weeks showed a significant change in total cholesterol reduction in the subjects of 15.29 mg/dl (p=0.00) or decreased by 8% (p=0.00) from the previous condition. There was also a significant LDL-c change of 10.45 mg/dl (p=0.01) or decreased by 9.32% from previous condition although not significant (p=0.06). The triglycerides was not significantly reduced by 3.73 mg/dl or 1.41% from the previous condition (p=0.07 and p=0.08). While the HDL-c showed a reverse change than expected although not significant i.e decreased by 2.70 mg/dl or 6.33% (p=0.59 and p=0.41). There was also a significant changes in body weight, it showed weight loss of 0.28 kg or 0.5% (p=0.04 and p=0.03).

Table 3: Changes in total cholesterol, HDL-c, LDL-c, triglycerides and weight Table 3 shows the result of multivariate analysis using ANOVA Repeated Measure

Variables	Group		p-value
	Treatment (n=17) (mean±SD)	Control (n=17) (mean±SD)	
Total Cholesterol (mg/dl)			
- Before Intervention	179.25 ± 22.17	164.57 ± 24.19	
After Intervention	163.95 ± 23.33	166.54 ± 24.30	
Changes	-15.29 ± 10.59	1.97 ± 12.19	0.00
Changes (%)	-8.51 ± 5.72	0.73 ± 8.87	0.00
HDL-c (mg/dl)			
- Before Intervention	51.29 ± 6.76	49.64 ± 6.56	
After Intervention	48.58 ± 9.40	48.47 ± 9.16	
Changes	-2.70 ± 7.10	-1.17 ± 9.44	0.59
Changes (%)	-6.33 ± 15.54	-1.62 ± 17.80	0.41
LDL-c (mg/dl)			
- Before Intervention	111.65 ± 22.93	98.53 ± 24.75	
After Intervention	101.20 ± 23.62	100.30 ± 25.06	
Changes	-10.45 ± 13.29	1.77 ± 12.67	0.01
Changes (%)	-9.32 ± 12.50	0.39 ± 16.56	0.06
Triglycerides (mg/dl)			
- Before Intervention	77.44 ± 31.12	86.68 ± 26.39	
After Intervention	73.70 ± 28.22	97.71 ± 30.11	
Changes	-3.73 ± 22.17	11.03 ± 23.72	0.07
Changes (%)	-1.41 ± 24.44	18.02 ± 37.19	0.08
Weight (kg)			
- Before Intervention	67.11 ± 10.30	67.85 ± 9.64	
After Intervention	66.77 ± 10.37	68.79 ± 9.39	
Changes	-0.28 ± 1.00	0.94 ± 2.21	0.04
Changes (%)	-0.53 ± 1.60	2.37 ± 5.30	0.03





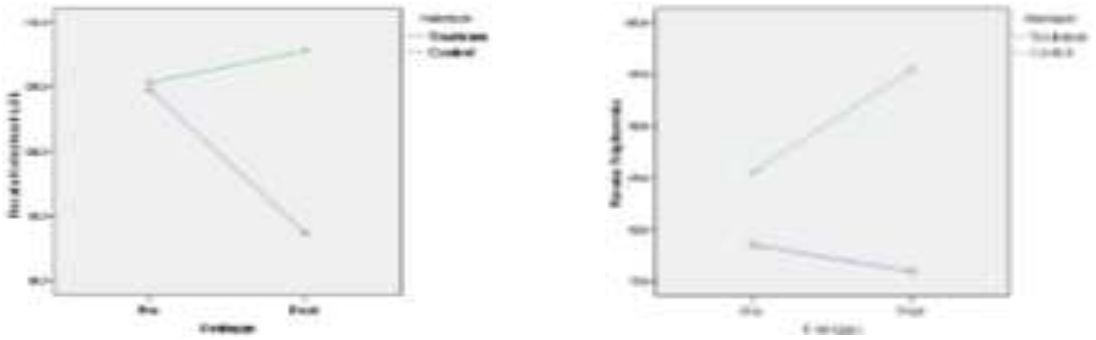


Figure 1. The changes of lipid profile after intervention

DISCUSSION

The addition of 3F2V for four weeks has increased the intake of fruit to 3.06 servings per day compared to the previous 1.71 servings, as well as the vegetable intake increased to 2.35 servings of 1.24 previously consumed. This amount is close to the suggestion of consuming 3-4 servings of vegetable and 2-3 servings of fruit [3]

The effect of supplemental intake of FV on total cholesterol, LDL-c and triglycerides showed a significant decrease from the condition before treatment (p=0.02, p=0.00, p=0.02). Studies showed that a diet rich in FV can have a positive effect on the prevention of dyslipidemia and oxidative stress, as well as other metabolic diseases. The positive effect is mediated primarily by the antioxidant vitamins (A, C and E), carotenoids, polyphenols and other important phytochemicals such as flavonoid[8,9,10].. These compounds are not considered as nutrients but much potential to prevent from chronic disease[8]. Polyphenol is predicted to restrict HMG-CoA reductase so that cholesterol synthesis in the liver is reduced so that liver cells form more receptors[11]. Flavonoid was associated with lower LDL-c susceptibility to oxidation. Penczynski *et al* (2018) reports that higher habitual flavonoid intake from fruit and vegetables is independently related to lower LDL-c in adolescence[12]. Many facts have proven that diet can have a strong effect on the development of oxidative stress and dyslipidemia, which in turn is related to the emergence of metabolic syndrome and cardio-vascular disease. It is now well known how oxidative stress develops and how cells can protect themselves, as well as some molecules that can be found in fruits and vegetables that contribute to reduce oxidative stress in cells and tissues[13].Some types of fruits and vegetables, especially red ones such as tomatoes, pink grapefruits, red grapes, watermelons and red guavas are due to the presence of lycopene[14]. Lycopene can restrict cholesterol synthesis by restricting the action of the HMG-CoA reductase enzyme and increasing the degradation of LDL-c[15]. Khayat Nouri *et al* (2013) reports that tomato had effect on lowering cholesterol, LDL-c and triglyceride in rats feeds with high cholesterol. These effects can be due to the antioxidant and lycopene effect by inhibiting lipid peroxidation and decrease the production of cholesterol, LDL-c and triglyceride[16].

American Dietetic Association (ADA) recommends fiber intake of 25 g/day (for adult women) and 38 g/day (for adult men) to protect from cardiovascular disease by lowering cholesterol level[5]. Sekgala *et al* suggest that the effectiveness of consumption 34 g dietary total fiber can decrease LDL-c by 20.057 mml/L (95%CI; 20.070, 20.044) or higher and decrease cholesterol by 20.045 mmol/L (95%CI; 20.054, 20.035) or higher[10]. The effect of fruits and vegetables on total cholesterol, LDL cholesterol and triglycerides may be due to the soluble fiber content contained in vegetables and fruits. Soluble fiber can interfere the absorption of fat and food cholesterol and enterohepatic cholesterol of cholesterol and bile acids[17,18]. Soluble fiber bind

cholesterol in the lumen of the small intestine then reduced the absorption of cholesterol. Soluble fiber also increase the fecal excretion of bile acids and cholesterol fecal excretion then decrease absorption of cholesterol and fatty acid[19] and also reduced LDL-c[4,5,10,18]. Other authors have found a correlation between diet containing fruits and vegetables with lower LDL-c concentrations in men and women. Study of obesity patients with metabolic syndrome by giving 2-3 cups of strawberries a day can lower total cholesterol, and LDL-c significantly[20]. Other studies in mice with provision of yellow pumpkin seed powder for 2 weeks were able to lower LDL-c in all treatment groups significantly[21].

Some of the cholesterol-lowering mechanisms by dietary fiber are restricting cholesterol absorption, decreasing cholesterol availability so that transfer to the blood stream is reduced, preventing cholesterol synthesis, decreasing food energy density thereby reducing cholesterol synthesis and increasing bile excretion. This cholesterol-lowering mechanism can be assessed by examining SCFA (short chain fatty acid)[19] and digestible caecum cholesterol[4,22]. SCFA consist of acetic, propionic, and butyric acids. Propionic acid also can be absorbed and inhibit the liver's rate-limiting cholesterol synthesis enzyme HMG-CoA reductase [4]. The results of research on rats that red guava proved to produce SCFA and digesta caecum cholesterol higher than pectin. The production of propionic acid and caecum cholesterol excretion may result in a decrease in serum cholesterol[23].HDL-c also reduce in this study but not significant. Lower HDL-c in this study still range in normal borderline. Study showed that HDL-c was significantly reduce in vegetarian diet not only LDL-c and total cholesterol[24]. Other study showed that fiber reported a significant reduction in triglyceride but didn't significant change in HDL-c[4].The effect of additional intake of vegetables and fruits on weight loss showed a significant decrease (p=0.04). Dietary fiber can lose weight by various mechanisms. Fiber consumption can also lead to a longer fullness so that energy intake can be regulated according to low-calorie and low-cholesterol dietary standards[5,25]. Vegetables and fruits generally have a high fiber content and a relatively lower energy. Foods rich in fiber need to be chewed longer, causing an increase in the time required to eat food and feeling full[5,26] then suppresses appetite[5,10]. It is also important to note that the effects of dietary fiber intake on weight may be related to different intestinal hormones that regulate fullness, energy intake and/or pancreatic function[6].

This study consistent with recommendation of World Health Organization (WHO) to consume a minimum of 400 g or 5 servings of FV daily[27] and also the Indonesia Ministry of Health suggests to consuming 3-4 servings of vegetable and 2-3 servings of fruit[3] in order to maintain our health especially for lower total cholesterol, LDL-c and triglyceride can be prevent the risk of coronary heart disease. Although no tolerable upper limit has been established for total fiber intake, it should be noted that side effect of high consumption of FV has been reported such as flatulence and abdominal discomfort[4].

CONCLUSION

The results of this study can be concluded as follows: 1) provision of 2 servings of vegetables and 3 servings of fruit for 4 weeks can lower total cholesterol, LDL cholesterol and triglycerides in overweight adolescents, but it can't increase HDL-cholesterol; 2) provision of additional 2 servings of vegetables and 3 servings of fruit for 4 weeks can lose weight on overweight adolescents.

Some suggestions that can be given are as follows: 1) consumption of 2 servings of vegetables and 3 servings of fruit every day can be used to control blood lipid profile to stay within the normal range; 2) it is necessary to do the same research with a subject that has been definitively diagnosed with dyslipidemia.

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