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Original Article

Effects of Fuji Apple Juice on Total Cholesterol Levels in Hypercholesterolemic Elderly People

Rizki Dwi Agustin Harsono[1*], Yulia Lanti Retno Dewi[2], Anik Lestari[2]

1- Postgraduate Program of Nutrition Scinece, Sebelas Maret University, Surakarta, Indonesia

2- Lecture, Faculty of Medicine, Sebelas Maret University, Surakarta, Indonesia

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ABSTRACT

Background and Objectives: In recent years, prevalence of hypercholesterolemia has increased, especially in elderly people who are susceptible to increased levels of total cholesterol. Apples include active ingredients that act as antioxidant, anti-proliferation, lipid oxidation inhibitor, anti-hypercholesterol, and weight loss agents. The aim of this study was to investigate how Fuji apple juice affected total cholesterol levels in elderly people.

Materials and Methods: This study was an experimental study that was carried out on 26 elderly people with a history of hypercholesterolemia, dividing into two major groups using randomized pre post test control group design with randomized controlled trial. The control group (G0) received no medication, while the experimental group (G1) received the Fuji apple juice of 200 ml for 14 days. Paired t-test and independent t-test were used to analyze the results.

Results: The mean pre-post G0 total cholesterol increased by 22.38 with, no significant changes ($p > 0.05$). The mean pre-post G1 total cholesterol decreased by 27.62, suggesting statistically significant changes ($p < 0.05$).

Conclusions: In conclusion, use of 200 ml of Fuji apple juice for 14 days decreased total cholesterol levels in hypercholesterolemia elderly people.

Keywords: Elderly People, Fuji Apple Juice, Total Cholesterol

Introduction

Hypercholesterolemia is a lipid metabolism disorder characterized by decreases in total cholesterol (TC) of ≥ 200 mg/dl (1). Elderly people are susceptible to increases in TC caused by changes in organ functions. In Indonesia, the proportion of elderly people with high TC is 50.7% (age 55 – 64 years), 48% (age 65 – 74 years) and 39% (age 75+ years) (2). In men and women aged 40 – 69 years, high TC levels are linked to coronary heart disease (CHD) (3). Naturally, apples include antioxidant, anti-proliferative, lipid oxidation inhibitory and, anti-hypercholesterolemia characteristics, and can help people lose weight (4-7).

Hypercholesterolemia can develop as a result of abnormalities in blood lipoprotein levels, which can develop atherosclerosis in long terms (4). Non-pharmacological therapies to prevent hypercholesterolemia include weight loss, increased physical activities, and dietary changes (5). Fuji apples include total phenolic contents of 417.5 mg GAE, flavonoids of 295 mg QE, and ascorbic acid of 25.4 mg per 250 ml of juice, making them appropriate for non-pharmacological therapies (6). Fuji apples include 52 calories per 100 g, 0.26 g of proteins, 0.17 g of fats, 13.8 g of carbohydrates, 2.4 g of fibers, and 4.6 mg of vitamin C (7).

Therefore, the aim of the current study was to investigate of Fuji apple juice on TC levels in hypercholesterolemia elderly people. The findings of this study are expected to provide scientific evidence of Fuji apple juice effects on decreasing TC levels, as well as increasing public knowledge about one of the most effective ways to decrease blood TC.

Materials and Methods

This study was an experimental study using pre post control group design with randomized controlled trial (RCT). The independent variable in this study included Fuji apple juice, while the dependent variable included TC level. The inclusion criteria included that participants did not smoke or drink alcohol, aged 60 – 74 years, and did not have a history of other diseases such as hypertension, diabetes mellitus, or other chronic diseases. The study

***Address for correspondence:** Rizki Dwi Agustin Harsono, Postgraduate Program of Nutrition Scinece, Sebelas Maret University, Surakarta, Indonesia
E-mail address: arizki930@gmail.com

included 26 participants, who were assigned into two groups of control group (G0) and experimental group (G1) received 200 ml of Fuji apple juice in the morning for 14 days. This study was carried out at Banyuputih Health Center, Situbondo Regency, Indonesia. After explaining the study protocol, all participants signed written informed consents. This study received Ethical Clearance from the Ethical Commission of the Faculty of Medicine, Sebelas Maret University, Indonesia (067/UN27.06.6.1/KEPK/EC/2020).

The sample size was calculated based on a sample size formula for hypothesis testing study in two average populations. The calculation was carried out by multiplying the average TC level (δ2) of 100 with 95% confidence level (Z1-α) of 1.96 and 90% test strenght (Z1-β) of 1.28. Then, this was divided by the mean difference between the control and treatment groups (μ1 – μ2) of 13.522. Therefore, a minimum number of 12 participants were selected as the study sample size. To anticipate the loss of participants, a 10% follow-up loss was added to the value, resulting a minimum number of 13 participants per group with a total of 26 research participants.

This study assessed data of the participant's personal, including sex, occupation, income, education, physical activity and body mass index (BMI). Food intakes such as energy, carbohydrates, proteins, fats, fibers and vitamin C were recorded using 2 x 24 h recalls before and after the interventions for 14 days (Table 3). Physical activities were assessed using global physical activity questionnaires.

Measurement of blood indicator

Blood was collected two times, before and after the interventions. Two mililiters of blood were collected from the veins in ethylene diamine tetraacetate (EDTA) tubes. Cholesterol oxidase-perioxidase aminoantypirin (CHOD-PAP) approach was used to assess TC levels enzymatically.

Statistical analysis

In this study, data analysis was carried out using SPSS Software v.23 (IBM Analytics, USA). Shapiro–Wilk test was used to check the normality. Bivariate tests were used to analyze effects of fuji apple juice on TC levels using paired t-test and independent t-test; where, $p \leq 0.05$ was reported as statistically significant.

Results

In this study, participants in aged 60 – 74 years, with up to 13 people per group and the majority of the female sex in G1 and G0 group (84.6 and 61.5%, respectively). The G1 group mostly worked as farmers and laborers (38.5%) with a range of income less than one million Rupiahs, while the G0 group member were mostly retirees (46.1%) with a monthly salary of 1 – 3 million Rupiahs. In terms of educational backgrounds of the two groups most of the participants of G1 and G0 group were high school graduates (69.2 and 38.5%, respectively). Each group did low physical activities (84.6%) (Table 1).

Table 1. Baseline characteristics of the participants (n = 26)

Characteristics	G0 (n = 13) (%)	G1 (n = 13) (%)
Gender		
- Male	5 (38.5)	2 (15.4)
- Female	8 (61.5)	11 (84.6)
Education		
- Non-attendee	0	1 (7.7)
- Elementary School	2 (15.4)	0
- Junior High School	2 (15.4)	3 (23.1)
- Senior High School	5 (38.5)	9 (69.2)
- University	4 (30.7)	0
Occupation		
- Retiree	6 (46.1)	1 (7.7)
- Enterpreneur	0	2 (15.4)
- Farmer and laborer	3 (23.1)	5 (38.5)
- Sell at home	1 (7.7)	1 (7.7)
- Unemployed	3 (23.1)	4 (30.7)
Income		
- < 1 million	6 (46.2)	6 (46.2)
- 1-3 million	7 (53.8)	7 (53.8)
Physical Activity		
- Low	11 (84.6)	11 (84.6)
- Moderate	2 (15.4)	2 (15.4)

Source : Primary Data, 2021. *Ministry of Health of the Republic of Indonesia, 2018. N: Population number, n: sample number, G0: Control group, G1: Fuji apple juice intervention.

Weight and BMI of G0 and G1 showed significant changes before and after the interventions ($p < 0.05$) (Table 2). Moreover, dietary intakes of G0 and G1 showed changes before and after the interventions ($p < 0.05$) (Table 3). Before and after the treatments, fuji apple juice consumption decreased blood TC (27.62 mg/dl). In contrast, the control group who did not received Fuji apple juice experienced increases in TC (22.38 mg/dl) (Table 4). Results of paired t-test analyze showed no significant changes before and after the interventions in G0 (p = 0.051), while significant changes were reported in G1 before and after the interventions (p = 0.000) (Table 4). Results of the independent t-test analysis for the comparison G0 with G1 showed significant changes before the interventions (p = 0.005) with, no significant changes after intevention (p = 0.207) while, significant changes were recorded in ΔTC (p = 0.001) (Tabel 4).

Tabel 2. Weights and body mass indices pre and post Interventions

	G0 (n=13)		G1 (n=13)		t
	Pre (M±SD)	Post (M±SD)	Pre (M±SD)	Post (M±SD)	
Weight (kg)	54.77±5.85	54.38±6.42	59.23±8.81	57.85±8.31	0.019*
BMI (kg/m^2)	24.32±3.73	24.18±4.02	24.96±3.58	24.40±3.84	0.026*

Source: Primary Data, 2021. G0: Control Group, G1: Fuji apple juice intervention group, n: Sample number, M: Mean, SD: Standar deviation, t: t-test.

Table 3. Mean dietary intakes pre and post interventions

	G0 (n=13)		G1 (n=13)		T
	Pre (M±SD)	Post (M±SD)	Pre (M±SD)	Post (M±SD)	
Energi (kcal)	1412.88±222.24	1198.26±138.25	1350.35±74.53	1229.60±68.35	0.000*
Protein (g)	46.64±7.65	41.04±3.39	45.35±5.91	43.85±3.26	0.000*
Fat (g)	37.19±9.43	34.13±3.69	43.03±7.13	28.33±0.53	0.000*
Carbohydrate (g)	222.26±41.64	183.90±28.86	197.43±17.74	204.98±16.02	0.015*
Fiber (g)	14.98±4.13	10.33±2.39	14.68±4.19	20.77±2.22	0.000*
Vitamin C (mg)	22.93±13.21	39.69±10.11	39.59±10.76	50.11±2.51	0.030*

Source: Primary Data, 2021. G0: Control Group, G1: Fuji apple juice intervention group, n: Sample number, M: Mean, SD: Standar deviation, t: t-test.

Tabel 4. Total cholesterol levels pre and post interventions

Group	n	Day 0 (M±SD)	Day 14 (M±SD)	ΔTC (M±SD)	t
G0	13	192.54±31.85	214.92±24.91	22.38±37.25	0.051
G1	13	232.54±20.37	203.38±20.21	-27.62±16.76	0.000*
P value	26	0.005*	0.207	0.001*	

Souce : Primary Data, 2021. G0: Control Group, G1: Fuji apple juice intervention group, ΔTC: Changes in total cholesterol, n: Sample number, M: Mean, SD: Standar deviation, t: t-test, P: p-value.

Discussion

Results of this study showed that elderly people with hypercholesterolemia who received 200 mL of Fuji apple juice for 14 days had lower blood TC levels. These results were similiar to those by Ravn-Haren *et al*., (2012), who reported that threatments with apples decreased cholesterol levels significantly in men and women aged 18 – 69 years. Consumption of whole apples decreased overall cholesterol levels further effectively (8).

Apple' fiber and antioxidant contents can contribute to decrease blood TC levels. Antioxidant and pectin contents in whole apples help decrease blood cholesterol levels. Flavonoids are antioxidants (e.g., quercetin and catechin) found in Fuji apples. Flavonoids can act as cofactors for the cholesterol esterase enzyme, inhibiting dietary cholesterol absorption by preventing micelle formation (9, 10). Fuji apples include sufficient vitamin C contents to avoid lipid peroxidation, decreasing metabolic stress caused by the free radicals (11). Furthermore, fiber contents in apples include hypolipidemic effects in digestive tract as fibers bind to bile acids and increase their excretion in feces. Since bile salts bound to fibers cannot be reabsorbed by the enterohepatic cycle, they are secreted through the feces, decreasing bile salts that reach the liver. This decrease results in increase in intake of cholesterol from the blood, which is synthesized back into new bile salts, decreasing cholesterol levels (12, 13).

Decreases in TC levels can be affected by weight loss and changes in BMI; as shown by a study of Achilona *et al*. (2016), which demonstrated significant relationships between the BMI and TC levels. Increases in BMI indicate the quantity of fat stored in the body and blood (14). Studies carried out in Negeria revelead that participants with high BMI values had blood lipid profiles, especially high TC levels (15). Accumulation of body fat mass causes an increases in the release of free fatty acids (FFA) which is form of absorption of triglycerides as a component of TC; hence, increases in BMI can be indicator of increases in TC levels (16, 17). Naturally, fat intake can affect blood TC levels. The average increase in fat intake in 100 mg/day can increase serum cholesterol by 2 – 3 mg/dl and consumption of high-fat foods can trigger increases in blood TC levels (18). In the current study, significant relationships were seen between the fat intake and increases in TC level in CHD patients if fat intake was more than 25% (19).

Increasing fiber consumption could decrease blood TC levels. This finding was similar to that of several studies where fiber intake was positively correlated with low-density lipoproteins-cholesterol (LDL-C) levels (20) and a high-fiber diet could be used for hypercholesterolemic patients to decrease blood TC levels (21).

Conclusion

In conclusion, consumption of Fuji apple juice of 200 ml for 14 days can decrease blood TC levels in

hypercholesterolemic elderly people, and therefore apple juice can be used as an alternative medicine in these people.

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