The Effect of Manalagi and Fuji Apple Juice on Triglyceride Level in Elderly

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ABSTRACT

The purpose of this study is to determine effect of manalagi and fuji apples juice on triglyceride levels in elderly. This study is an experimental study conducted on 39 elderly for 14 days, divided into 3 groups through randomized pre-post test control group design. G-0 was the control group, G-1 was the intervention group administered with manalagi apple juice, and G-2 was the intervention group given fuji apple juice. The data obtained were analyzed using Kruskal-Wallis and Mann-Whitney test. Tryglyceride levels in the G-0 increased, whereas the G-1 and G-2 decreased. There was a significant difference (P <0.05) between the G-0 and the intervention group. Consumption of manalagi and fuji apples juice could reduce triglyceride levels in elderly.

Keywords: Elderly, Fuji Apple Juice, Manalagi Apple Juice, Triglyceride Levels

JEL Classification Codes: I10, I20, I19

INTRODUCTION

With increasing age, one will eventually experience an aging process signified by a decrease in organ function, such as cardiac function (Fatmah, 2010). An effect of the declining function of the heart organ is hypercholesterolemia which occurs due to long-term abnormalities of blood lipoprotein levels which will accelerate the prevalence of atherosclerosis (Bantas et al., 2012). Triglycerides are the main lipids in food so that high triglyceride levels in the blood will increase the VLDL concentration which may enhance the risk of plaque formation in the arteries (Miller et al., 2011).

Lipids in the diet consist of triglycerides (the most abundant type of fat), phospholipids and cholesterol (Botham & Mayes, 2012; Mahley, 2001; Semenkovich et al., 2011). Lipids function as an energy source, heat insulator in sub-cutaneous tissue, energy reserves (triglycerides), adrenal hormone precursors and gonadal steroids and cholesterol bile acids (Botham & Mayes, 2012). Lipids are generally hydrophobic (Semenkovich et al., 2011) and therefore require a solvent, namely apoprotein. Lipid is divided into cholesterol, High Density Lipoprotein (HDL), Low Density Lipoprotein (LDL), and Triglycerides (Rembang et al., 2015).

Triglycerides are the main lipid storage in adipose tissue, this form of lipid will be released after it occurs hydrolysis by hormone-sensitive lipase enzymes into free fatty acids and glycerol (Marks et al., 2000). Free fatty acids will be linked on serum albumin and for its transport to tissues, where it is used as a source of important fuel (Marks et al., 2000). Triglycerides are alcohol esters of glycerol and fatty acids consisting of three fatty acid molecules, namely saturated fat, monounsaturated fat, and polyunsaturated fat (Wibawa, 2009). Triglycerides are
used by the body primarily to provide energy in metabolic processes, small amounts of triglycerides are also used throughout the body to form cell membranes. Triglycerides in the blood form complexes with certain proteins (apolipoprotein) to form lipoproteins. Lipoprotein is the form of transportation used for triglycerides (Wibowo, 2009). Triglycerides are the main source of energy for various body activities (Fauziyah & Suryanto, 2012).

Triglycerides is a form of lipid that is absorbed by the intestine after hydrolysis, then enters the plasma in 2 forms, namely as chylomicrons derived from intestinal absorption after consuming lipid and VLDL (Very Low Density Lipoprotein) which is formed by the liver with the help of insulin. Triglycerides found in blood vessels, muscles, and adipose tissue are hydrolyzed by the enzyme lipoprotein lipase. The rest of the hydrolysis will be metabolized into LDL (Low Density Lipoprotein) by the liver. Cholesterol contained in LDL will be captured by special receptors in peripheral tissues (Graha, 2010).

In 2016, 41 million deaths occured due to non-communicable diseases and one of them is cardiovascular disease (17.9 million deaths and accounting for 44% of all deaths from non-communicable disease) (WHO, 2018). In Indonesia, cardiovascular disease is 30% of the causes of death and is the largest proportion of existing causes of death (WHO, 2011). In Indonesia, the proportion of abnormal triglyceride levels is 17% (55-64 years), 14% (65-74 years), and 15% (75+ years) (The George Institute for Global Health, 2017). Meanwhile, the prevalence of heart disease is 3.9% (55-64 years), 4.6% (65-74 years), and 4.7% (75+ years) (Ministry of Health, Republic of Indonesia, 2018).

Efforts to prevent an increase in triglyceride levels can be carried out through non-pharmacological therapy, which is meal planning by reducing fat intake, adding fiber and antioxidant intake (NCEP, 2002). Apple is a fruit containing phytochemical compounds that function as antioxidants, inhibitors of lipid oxidation, and anti-hypercholesterolemia (Aprikan et al., 2003; Eberhardt et al., 2000; Liu et al., 2001; Wolfe et al., 2003). Manalagi apple contains quercetin of 406.57 mg/L and juice of 185 mg/L, while Fuji apple accommodates quercetin of 272.89 mg/L and juice of 133.9 mg/L (Cempaka et al., 2014).

The consumption rate of manalagi apples is quite high among the people with a value reaching 875 g/person/month (Sumanwan, 2011). Manalagi apples have a sweet taste even though they are young and have a fragrant aroma (Hapsari & Teti, 2015). The shape of the fruit is round and the skin of the fruit is white (Hapsari & Teti, 2015). If wrapped in the skin of the fruit is light green yellowish, while if left unchecked the color will remain green (Hapsari & Teti, 2015). Fruit diameter ranges from 5-7 cm and weight 75-100 g/fruit (Hapsari & Teti, 2015).

Fuji apples is the result of a cross between Rall Janet (Kakko) and Red Delicious which was developed by The Fruit Tree Research Station (National Institute of Fruit Tree Science) MAFF, Japan (Pudjiatmoko. 2008). Fuji apples weight about 300 grams, are round to oblong in red to dark reddish brown in color (Pudjiatmoko, 2008). Striped clear with a yellow base color and the fruit is sweet with a moderate sour taste, contains a lot of juice and tastes good (Pudjiatmoko, 2008). Flesh yellowish white, hard, and slightly rough (Pudjiatmoko, 2008). Tends to contain a lot of water. The sugar content is about 15%, the acidity is 0.4 – 0.5% and the pulp hardness is about 15 pounds (Pudjiatmoko, 2008).

Apple consumption in Indonesia in 1999 was 0.15 kg/capita/year and increased in 2002 by 0.61 kg/capita/year (Direktorat Jenderal Bina Produksi Hortikultura, 2002). The Central Bureau of Statistics shows that in 1985 – 1987 the average
consumption of apples in Indonesia increased by 0.02% per year with an average consumption of apple of 0.6 kg/capita/year (Cempaka et al., 2014), while in 2006 the average consumption of apples in Indonesia reached 1.1 kg/capita/year (Huda et al., 2015).

Research probed by Abedinzade et al. (2015) shows that administering apple juice concentrations of 10% and 25% to orchidectomy in mice for 60 days reduced total cholesterol and triglyceride levels. Provision of red apple skin supplementation with a dose of 3 tablets/day for 5-6 weeks reduced total cholesterol and triglyceride levels (Al-Hamdani, 2015). Dispensing green apple juice for 7 days reduced total cholesterol levels in hypercholesterolemic patients with hypertension (Izzati & Salsabila, 2018).

Given the background, the researchers analyze the administration of manalagi and fuji apples juice to decrease blood triglyceride levels in elderly.

**RESEARCH METHOD**

This research is an experimental study with a pre-post control group design. The independent variables are manalagi apple juice and fuji apple juice, while the dependent variable is triglyceride levels. Subjects involved in this study were elderly men and women aged ≥ 60 years, did not smoke, did not consume alcohol, did not have a history of other diseases. All subjects in this study signed informed consent after being explained the research procedure. This research has received Ethical Clearance from the Ethical Commission of the Faculty of Medicine, Sebelas Maret University No 067/UN27.06.6.1/KEPK/EC/2020.

The research subjects comprised 39 individuals who were selected according to the inclusion criteria and divided into 3 groups, namely the control group (G-0), G-1 treatment group (manalagi apple juice intervention), and G-2 treatment group (Fuji apple juice intervention). Juice intervention was administered as much as 200 ml for 14 days. The research was conducted in the Banyuputih Community Health Center, Situbondo Regency, East Java.

In addition, this study evaluated data on subject characteristics, which are gender, occupation, income, education, physical activity, and nutritional status. Further, food intake, such as energy, carbohydrates, protein, fat, fiber, and vitamin C, was recorded using a 2x24 hour recall after manalagi apple juice and fuji apple intervention for 14 days. The nutritional content of manalagi apple and fuji apple is presented in Table 1. The average food intake of the subjects is categorized as inadequate, adequate, and very adequate as shown in Table 2. Measurement of physical activity using a Global Physical Activity Questionnaire.

| Nutritional Content | Manalagi Apple | Fuji Apple |
|---------------------|----------------|-----------|
| Fiber               | 3.2 %          | 8.7 %     |
| Pectin              | 1.3 %          | 1.7 %     |
| Total Phenolic      | 109.01 mg GAE  | 118.04 mg GAE |
| Flavonoid           | 76.19 mg QE    | 58.31 mg QE |
| Vitamin C           | 12.08 mg       | 4.56 mg   |

Source: Anggraini (2016), Anggraiani et al. (2018), Aziz et al. (2017), Pyo et al. (2014), Putri et al. (2017)
Table 2. Information on Subject' Dietary Intake (N= 39)

| Characteristics         | G-0 (n=13) (%) | G-1 (n=13) (%) | G-2 (n=13) (%) |
|--------------------------|----------------|----------------|----------------|
| Energy Intake*           |                |                |                |
| - Less                   | 0              | 0              | 1 (7.7)        |
| - Enough                 | 10 (76.9)      | 11 (84.6)      | 10 (76.9)      |
| - More                   | 3 (23.1)       | 2 (15.4)       | 2 (15.4)       |
| Protein Intake*          |                |                |                |
| - Less                   | 11 (84.6)      | 6 (46.2)       | 8 (61.5)       |
| - Enough                 | 2 (15.4)       | 7 (53.8)       | 5 (38.5)       |
| - More                   | 0              | 0              | 0              |
| Fat Intake*              |                |                |                |
| - Less                   | 0              | 0              | 2 (15.4)       |
| - Enough                 | 3 (23.1)       | 12 (92.3)      | 11 (84.6)      |
| - More                   | 10 (76.9)      | 1 (7.7)        | 0              |
| Carbohydrate Intake*     |                |                |                |
| - Less                   | 0              | 0              | 0              |
| - Enough                 | 12 (92.3)      | 12 (92.3)      | 12 (92.3)      |
| - More                   | 1 (7.7)        | 1 (7.7)        | 1 (7.7)        |
| Fiber Intake*            |                |                |                |
| - Less                   | 12 (92.3)      | 2 (15.4)       | 1 (7.7)        |
| - Enough                 | 1 (7.7)        | 11 (84.6)      | 12 (92.3)      |
| - More                   | 0              | 0              | 0              |
| Vitamin C Intake*        |                |                |                |
| - Less                   | 12 (92.3)      | 1 (7.7)        | 1 (7.7)        |
| - Enough                 | 1 (7.7)        | 12 (92.3)      | 12 (92.3)      |
| - More                   | 0              | 0              | 0              |

Source: Primary Data, 2021.
*Ministry of Health of Republic of Indonesia, 2018.

Blood draws were carried out 2 times before and after the intervention. Blood was drawn through a vein of 2 cc which was placed in the EDTA (ethylene diamine tetra acetate) tube. The triglyceride level analysis procedure was determined based on enzymatic by the GPO-PAP (Glycerol-3-Phosphatase-Oxidase) method. In this study, data analysis using SPSS Software v.23. Shapiro Wilk was used to check the normality. Univariate analysis was carried out to assess the distribution of general characteristics of subjects such as gender, occupation, income, education, physical activity, food intake, and triglyceride levels. The bivariate analysis examined the intervention effect of Manalagi apple juice and fujit apple juice on triglyceride levels using non-parametric tests, comprising the Kruskal-Wallis test and the Mann-Whitney test, where P ≤ 0.05 are considered statistically significant.

RESULTS AND DISCUSSION

The characteristics of the research subjects are shown in Table (3). Triglyceride levels before and after the intervention showed that the intervention group Fuji apple juice experienced a decrease (15.31 mg/dl), which is higher than the intervention group Manalagi apple juice (12.23 mg/dl), while the control group appeared to have an increase in triglyceride levels (2.23 mg/dl) (Table 4).
### Table 3. Baseline characteristics of research subject (N = 39)

| Characteristic          | G-0 (%) | G-1 (%) | G-2 (%) |
|-------------------------|---------|---------|---------|
| Gender                  |         |         |         |
| - Male                  | 5 (38.5)| 3 (23.1)| 2 (15.4)|
| - Female                | 8 (61.5)| 10 (76.9)| 11 (84.6)|
| Education               |         |         |         |
| - Non-attendee          | 0       | 0       | 1 (7.7) |
| - Elementary School     | 2 (15.4)| 3 (23.1)| 0       |
| - Junior High School    | 2 (15.4)| 4 (30.7)| 3 (23.1)|
| - Senior High School    | 5 (38.5)| 5 (38.5)| 9 (69.2)|
| - University            | 4 (30.7)| 1 (7.7) | 0       |
| Occupation              |         |         |         |
| - Retiree               | 6 (46.1)| 1 (7.7) | 1 (7.7) |
| - Enterpreneur          | 0       | 3 (23.1)| 2 (15.4)|
| - Farmer and laborer    | 3 (23.1)| 4 (30.7)| 5 (38.5)|
| - Sell at home          | 1 (7.7) | 2 (15.4)| 1 (7.7) |
| - Unemployed            | 3 (23.1)| 3 (23.1)| 4 (30.7)|
| Income                  |         |         |         |
| - < 1 million           | 6 (46.2)| 8 (61.5)| 6 (46.2)|
| - 1-3 million           | 7 (53.8)| 5 (38.5)| 7 (53.8)|
| Physical Activity       |         |         |         |
| - Low                   | 11 (84.6)| 10 (76.9)| 11 (84.6)|
| - Moderate              | 2 (15.4)| 3 (23.1)| 2 (15.4)|
| Nutritional Status*     |         |         |         |
| - Underweight           | 0       | 0       | 0       |
| - Normal                | 8 (61.5)| 7 (53.8)| 7 (53.8)|
| - Overweight            | 5 (38.5)| 6 (46.2)| 6 (46.2)|

Source: Primary Data, 2021.
*Ministry of Health of the Republic of Indonesia, 2018.
N: Population number, G0: Control group, G1: Manalagi apple juice intervention, G2: Fuji apple juice intervention

### Table 4. Triglyceride level before and after intervention (N = 39)

| Group | n   | Day 0 (M±SD)       | Day 14 (M±SD)      | ∆TG (M±SD) |
|-------|-----|--------------------|--------------------|------------|
| G-0   | 13  | 139.00±21.86       | 141.23±16.95       | 2.23±14.79 |
| G-1   | 13  | 149.77±15.51       | 137.54±17.81       | -12.23±8.31|
| G-2   | 13  | 160.62±13.94       | 145.31±19.45       | -15.31±16.72|
| P value| 39 | 0.011*             | 0.494              | 0.12*      |

Source: Primary Data, 2021.
G-0 (Control group), G-1 (Manalagi apple juice intervention group), G-2 (Fuji apple juice intervention group), ∆TG (Changes in triglyceride level), n (sample number), M (Mean), SD (standar deviation), *P < 0.05 (Uji Kruskal-Wallis)

### Table 5. Comparative analysis of change in triglyceride level

| Group       | ∆TG (M±SD) | P value |
|-------------|------------|---------|
| G-0: G-1    | 2.23±14.79 | -12.23±8.31 | 0.006* |
| G-0: G-2    | 2.23±14.79 | -15.31±16.72 | 0.021* |
| G-1: G-2    | -12.23±8.31 | -15.31±16.72 | 0.776 |

Source: Primary Data, 2021.
G-0 (control group), G-1 (Manalagi apple juice intervention group), G-2 (Fuji apple juice intervention group), ΔTG (Changes in triglyceride level), M (Mean), SD (standard deviation), *P < 0.05 (Uji Mann-whitney)

There was a significant difference (P <0.05) between the control group (G-0) and intervention groups (G-1 and G-2) which exhibited a decrease in triglyceride levels in the intervention group, in contrast to an increase in triglyceride levels in the control group (Table 5).

In the comparison of triglyceride levels before and after the intervention, there was a 10% decrease in triglyceride levels after fuji apple juice consumption and an 8% decrease during manalagi apple juice consumption. Comparison between the control group and the intervention groups indicated increased triglyceride levels by 2% in the control group. The declining triglyceride levels that occurred in this study may have resulted from fiber and antioxidant content in manalagi and fuji apples that will bind bile acids and excrete them through feces. These findings correspond to the study that treated whole apples in male and female subjects aged 18-69 years for 4 weeks to reduce triglyceride levels (Ravn-Haren et al., 2012).

Supplementation of red apple skin with a dose of 3 tablets/day for 5-6 weeks reduced triglyceride levels (Al-Hamdani, 2015). Dispensing green apple juice for 7 days to those with hypertension lowered total cholesterol levels (Izzati & Salsabila, 2018).

The nutritional content of manalagi and fuji apples, such as fiber and antioxidants, affects the metabolism of triglycerides in the body. Antioxidants can prevent LDL oxidation and reduce lipid peroxidation (U.S. Department of Agriculture, 2005). Vitamin C is one of the antioxidant contents in apples which functions to maintain normal LDL (Low Density Lipoprotein) levels and helps the hydroxylation reaction in the formation of bile salts which will cause cholesterol excretion to increase so that it can reduce blood cholesterol (Dini et al., 2017). Vitamin C as an antioxidant can inhibit leptin secretion (Gracia-Diaz et al., 2010) and lipolysis will occur in which the Hormone Sensitive Lipase (HSL) enzyme hydrolyzes triglycerides into fatty acids and glycerol (Ronghua & Barouch, 2007).

The polyphenol content of apples included determination of proanthocyanidins oligomers and polymers (representing about 80% of apple polyphenols) (Vrhovsek et al., 2004; Wojdylo et al., 2008). Proanthocyanidins are known as condensed tannins i.e. oligomeric and flavonol polymers and consist mainly of (+)-epicatechins, although some terminal units may be of (+)-catechins. The most common apple polyphenol subclass are procyanidins which consist of (epi)catechin units (Monagas et al., 2010). The average concentration of total polyphenols was 110.2 mg/100 gr of fresh fruit and ranged from 66.2 – 221.9 mg/100 gr according to the following order of increase: Fuji, Braeburn, Royal Gala, Golden Delicious, Morgenduft, Granny Smith, Red Delicious, and Renetta (Vrhovsek et al., 2004). The phenolic compounds in apples are not evenly distributed in the fruit tissue. Despite the small contribution of apple peels (6 – 8 %) to whole fruit weight (Lata et al., 2009), fruit peels contain significantly higher phenolic content, in particular all flavonols (quercetin conjugates) and anthocyanins, as well as an important part of hydroalcone (phloridzin and phloretin glycosides) (Tsao et al., 2003; Vrhovsek et al., 2004). The polyphenol content in apple can also affect lipid metabolism including activation of fatty acid β-oxidation and cholesterol catabolism, inhibition of hepatic fatty acid synthesis, decreased cholesterol esterification and secretion of apoB (Apolipoprotein-B) containing lipoprotein, and suppression of CETP (Cholesterol Ester Transfer Protein) activity which increases the distribution of cholesterol in lipoprotein (Lam et al., 2008; Ohta et al., 2006; Osada et al., 2006; Vidal et al., 2005). Apple
phenolic compounds also with reduced oxidation LDL (Low Density Lipoprotein) (Thilakarathna et al. 2013). Previous research expresses that high consumption of fiber may reduce triglyceride levels (Reimer et al., 2011). Proanthocyanidins can inhibit the action of digestive enzymes such as lipase and amylase with the beneficial effects on lipid and glucose metabolism. Apple oligomeric procyanidins have shown to inhibit pancreatic lipase activity, with increased inhibition associated with high polymerization rates, influencing postprandial triacylglycerol uptake (Sugiyama et al., 2007). Upregulation of Lipoprotein Lipase activity has been suggested as an alternative mechanism of Triacylglycerol reduction (Yao et al., 2014). Proanthocyanidins can also regulate lipid metabolism by activating the FXR (Farnesoid X Receptor) and by modulating other nuclear receptors such as SHP (Small Heterodimer Partner) and PPAs (Peroxisome Proliferator-Activated Receptors) as well as transcription factors such as proteins that bind to steroid response elements (Blade et al., 2010; Del Bas et al., 2009).

Fiber functions to abate the gastric emptying time, increase the thickness of the intestinal wall which serves as a place for lipid absorption. Moreover, fiber can inhibit the absorption and metabolism of bile acids by binding to bile acids and increasing excretion through feces (Yap et al., 2007). Apples contain about 2-3% fiber and pectin is the main soluble fiber that has cholesterol-lowering properties (Brouns et al., 2012; Feliciano et al., 2010). Pectin is resistant to degradation of gastric acid and enzymes intestine so that when it reaches the intestine, pectin is fermented by the gut microbiota into short-chain fatty acids, butyrate, and propionate (Licht et al., 2010; Wong et al., 2012). Butyrate plays a major role in colonic function, has been shown to inhibit hepatic cholesterol synthesis, whereas acetate and propionate have an impact on metabolic processes at the systemic level, and have opposite effects on lipid metabolism (Wong et al., 2012). In the digestive tract, fiber can bind bile salts which are the end products of cholesterol and cholesterol then excreted with feces, so that fiber can reduce cholesterol levels in blood plasma and can reduce the amount of cholesterol levels going to the liver (Huang et al., 2017). The pectin content in apples has been shown to reduce plasma total cholesterol in human (Kevers et al., 2011). A meta-analysis concluded that 1 gr of pectin can reduce total cholesterol and LDL (Low Density Lipoprotein) by 0.70 and 0.055 mmol/L. Polyphenols in apples can also reduce total cholesterol and LDL (Low Density Lipoprotein) cholesterol with different doses in mild hypercholesterolemic subjects (Nagasako–Akazome et al., 2005).

CONCLUSIONS

Consumption of 200 ml of Manalagi and Fuji apple juice for 14 days may reduce triglyceride levels in elderly. The group that was administered Fuji apple juice experienced a higher decrease in triglyceride levels compared to the group that was dispensed manalagi apple juice.

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