Journal of International Conference Proceedings (JICP) Vol. 4 No. 1 (2021)
Print ISSN: 2622-0989 / Online ISSN: 2621-993X
DOI: https://doi.org/10.32535/jicp.v4i1.1155

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

Rizki Dwi Agustin Harsono[1], Yulia Lanti Retno Dewi[2], Anik Lestari[3]
Postgraduate Program of Nutrition Science, Sebelas Maret University Surakarta[1]
Faculty of Medicine, Sebelas Maret University Surakarta[2,3]
Ir. Sutami Street No. 36A, Kentingan, Jebres, Surakarta 57126, Central Java, Indonesia
Correspondence Email: arizki930@gmail.com

ABSTRACT

The purpose of this study is to determine effect of manalagi and fuji apples juice on triglyceride levels in 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. Trygliceride 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), phospolipids 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 (apoprotein) 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 (Sumarwan, 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). Fujii 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 connsumption in Indonesia in 1999 was 0.15 kg/capita/year and icreased 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 Phyisical Activity Questionnaire.

Table 1. The nutritional content of manalagi apple and Fuji apple per 100 g

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 fuji apple juice on triglyceride levels using non-parametric tests, comprising the Kruskal-Wallis test and the Mann-Whitney test, where $P \leq 0.05$ 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

Tabel 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.

Print ISSN: 2622-0989 / Online ISSN: 2621-993X
DOI: https://doi.org/10.32535/jicp.v4i1.1155

G-0 (control group), G-1 (Manalagi apple juice intervention group), G-2 (Fuji apple juice intervention group), ∆TG (Changes in triglyceride level), M (Mean), SD (standar 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 Llipoprotein) 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 consentration 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 hydrocalcone (phloridzin and phroletin 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*) (Thilakaranthna 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 ass 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.

REFERENCES

Abedinzade, M., Harialchi, K., Khanaki, K., & Khosravi, M. (2015). The effect of apple juice on antioxidant enzymes and lipid profiles in orchidectomized rats. *Zahedan Journal of Research in Medical Sciences*, 17(3), 12-15. http://dx.doi.org/10.5812/zjrms.1132

Al-Hamdani, H. M. S. (2015). Effect of consumstion dried apple peel and ginger on blood levels of cholesterol. *Advanced in Life Science and Technology*, *33*, 1-9.

Anggraini, D. (2016). *Hasil analasis laboratorium Ekstrak Apel Manalagi dan Ekstrak Apel Fuji.* Universitas Udayana.

Anggraiani, D., Sukrama, I. D. M., & Pertiwi, N. K. F. R. (2018). Jus Apel Manalagi (*Malus Sylvestris Mill*) menghambat pertumbuhan *Streptococcus Mutans* in Vitro. *Bali Dental Journal*, *2*, 59-64.

Aprikan, O., Duclos, V., Guyot, S., Besson, C., Manach, C., Bernalier, A., Morand, C., Rémésy, C., & Demigné, C. (2003). Apple pectin and a polyphenol rich apple concentrate are more effective together than separately on cecal fermentation and plasma lipids in rats. *The Journal of Nutrition, 133*, 1860-1865. https://doi.org/10.1093/jn/133.6.1860

Aziz, M., Anwar, M., Uddin, Z., Amanat, H., Ayyub, H., & Jadoon, S. (2013). Nutrition comparison between genus of apples (*Malus sylvestris and malus domestica*) to show which cultivar is best for the province of Balochistan. *Journal of Asian Scientific Research, 3*(4), 417-424.

Bantas, K., Agustina, F. M. T, & Zakiyah, D. A. (2012). Risiko hiperkolesterolemia pada pekerja di kawasan. *Jurnal Kesehatan Masyarakat*, *6*, 1-2. https://doi.org/10.21109/kesmas.v6i5.87

Blade, C., Arola, L., Salvado, M.J. (2010). Hypolipidemic Effect of Proanthocyanidins and Their Underlying Biochemical and Molecular Mechanisms. *Mol. Nutr. Food Res*, 54, 37-59.

Botham, K.M., & Mayes, P.A. (2012). *Bioenergenetika dan Metabolisme Karbohidrat serta Lipid.* Jakarta: Penerbit EGC.

Brouns, F., Theuwissen, E., Adam, A., Bell, M., Berger, A., Mensink, R.P. (2012). Cholesterol-lowering Properties of Different Pectin Types in Midly Hypercholesterolemic Men and Women. *Europe Journal Clin. Nutr*, 66: 591-599. Doi: 10.1038/ejcn.2011.208.Epub 2011 Dec 21.

Cempaka, A. R., Santoso, S., & Tanuwijaya, L. K. (2014). Pengaruh metode pengolahan (*juicing dan blending*) terhadap kandungan quercetin berbagai varietas apel lokal dan impor (*Malus domestica*). *Indonesia Journal of Human Nutrition*, *1*, 14-22.

Del Bas, J.M., Ricketts, M.L., Vaque, M., Sala, E., Quesada, H., Ardevol, A., Salvado, M.J., Blay, M., Arola, L., Moore, D.D. (2009). Dietary procyanidins enhance transcriptional activity in bile acid-activated FXR in vitro and reduce triaglyceridemia in vivo in a FXR-dependent Manner. *Mol. Nutr. Food Res*, 53, 805-814.

Dini, C.Y., Sabila, M., Habibie, I. Y., & Nugroho, F. A. (2017). Asupan vitamin C dan E tidak mempengaruhi kadar gula darah puasa pasien DM Tipe 2. *Indonesian Journal of Human Nutrition, 4*(2), 65-78.

Direktorat Jenderal Bina Produksi Hortikultura. (2002). *Statistik pertanian (Produk Hortikultura Indonesia).* Departemen Pertanian.

Eberhardt, M., Lee, C., & Liu, R. H. (2000). Antioxidant activity of fresh apples. *Nature*, *405*, 903-904. https://doi.org/10.1038/35016151

Fatmah. (2010). *Gizi lanjut usia*. Erlangga.

Fauziyah, Y.N., & Suryanto. (2012). *Perbedaan kadar trigliserida pada penderita diabetes mellitus Tiper 2 terkontrol dengan diabetes mellitus Tipe 2 tidak terkontrol.* Fakultas Kedokteran dan Ilmu Kesehatan Universitas Muhammadiyah Yogyakarta.

Feliciano, R. P., Antunes, C., Ramos, A., Serra, A. T., Figueira, M. E., Duarte, C. M. M., de Carvalho, A., Bronze, M. R. (2010). Characteristization of traditional and exotic apple varities from Portugal: Part 1-nutritional, phytocemichal and sensory evaluation. *Journal of Funct. Food*, 2, 35-45.

Gracia-Diaz, D. F, Campion, J., Milagro, F. I., Boque, N., Moreno-Aliaga, M. J., & Martinez, J. A. (2010). Vitamin C inhibits leptin secretion and some glucose/lipid metabolic pathways in primary rat adipocytes. *Journal of Molecular Endocrinology, 45*(1), 33-43. Doi: 10.1677/JME-09-0160.

Graha, K.C. (2010). *Kolesterol*. PT Elex Media Komputindo.

Hapsari & Teti. (2015). Variasi proses dan grade apel (*Malus sylvestris mill*) pada pengolahan minuman sari buah apel. *Jurnal Pangan dan Agroindustri*, *3*(3), 939-949.

Huang, C. N., Wang, C., Lin, C., Lin, H., & Peng, C. (2017). Active subfranctions of abelmoschus esculentus substantially prevent free fatty acid-induced β cell apoptosis via inhibiting dipeptidyl peptidase-4. *PloS One*, *12*(17), 1-16.

Huda, H. H., Aditya, G., & Praptiningsih, R. S. (2015). Efektivitas konsumsi buah apel (*Phyrus malus*) jenis Fuji terhadap skor plak gigi dan pH saliva. *Medali Journal*, *2*(1), 9-13.

Izzati, W., & Salsabila R. M. V. (2018). Pengaruh jus apel hijau terhadap penurunan kolesterol total pada penderita hipertensi di nagari kapalo koto wilayah kerja puskesmas tigo baleh Bukittinggi tahun 2017. *Jurnal Ilmu Kesehatan 'Afiyah*, *5*(1), 66-70.

Kevers, C., Pincemail, J., Tabart, J., Defraigne, J. O., & Dommes, J. (2011). Influence of cultivars, harvest time, storage conditions, and peeling on the antioxidant capacity and phenolic and ascorbic acid contents of apples and pears. *Journal Agric. Food Chem, 59*, 6165-6171.

Lam, C. K., Zhang, Z. S., Yu, H. J., Tsang, S. Y., Huang, Y., & Chen, Z. Y. (2008). Apple polyphenols inhibit plasma CETP activity and reduce the ratio of Non-HDL to HDL cholesterol. *Mol Nutr. Food Res, 52*, 950-958. Doi: 10.1007/s11655-012-1243-3.

Lata, B., Trampczynka, A., & Paczena, J. (2009). Cultvar variation in apple peel and whole fruit phenolic composition. *Sci. Hortic*, *121*, 176-181.

Licht, T. R., Hansen, M., Bergstrom, A., Poulsen, M., Krath, B. N., Markowski, J., Dragsted, L. O., & Wilcks, A. (2010). Effect of apples and specific apple component on the cecal environment of conventional rats: Role of apple pectin. *BMC Microbial*, *10*(13), 1-11.

Liu, R. H., Eberhardt, M., & Lee, C. (2001). Antioxidant and antiproliferative activities of selected New York apple cultivars. *New York Fruit Quarterly*, *9*, 15-17.

Mahley, R. W. (2001). Biochemistry and Physiology of lipid and lipoprotein metabolism. In *Principles and practice of endocrinology and metabolism.* Lippincott William & Wilkins.

Marks, D. B., Marks, A. D., & Smith, C. M. (2000). *Biokimia kedokteran dasar*. Penerbit Buku Kedokteran EGC.

Miller, M., Stone, N. J., Ballantyne, C., Bittner, V., Criqui, M. H., Ginsberg, H. N., Goldberg, A. C., Howard, W. J., Jacobson, M. S., Kris-Etherton, P. M., Lennie, T. A., Levi, M., Mazzone, T., & Pennathur, S. (2011). Triglycerides and cardiovascular disease. *Circulation American Heart Association Journals*, *123*, 2292-2333. https://doi.org/10.1161/CIR.0b013e3182160726

Ministry of Health of the Republic of Indonesia. (2018). *Riset dasar 2018*. Badan Penelitian dan Pengembangan Kesehatan.

Monagas, M., Urpi-Sarda, M., Sanchez-Patan, F., Llorach, R., Garrido, I., Gomez-Cordoves, C., Andres-Lacueva, C., & Bartolome, B. (2010). Insight into the metabolism and microbial biotransformation of dietary Flavan-3-ols and the bioactivity of their metabolism. *Food Function*, *1*, 233-253.

Nagasako-Akazome, Y., Kanda, T., Ikeda, M., & Shimasaki, H. (2005). Serum cholesterol-lowering effect of apple polyphenols in healthy subject. *Journal of Oleo Sci., 54*, 143-151.

NCEP. (2002). Third report of the national cholesterol education program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adults Treatment Panel III) final report. *Circulation*, *106*, 31-34.

Ohta, Y., Sami, M., Kanda, T., Saito, K., Osada, K., & Kato, H. (2006). Gene expression analysis of the anti-obesity effect by apple polyphenols in rats fed a high fat diet or a normal diet. *Journal Oleo Sci, 55*, 305-314. Doi: 10.5650/jos.55.305.

Osada, K., Suzuki, T., Kawakami, Y., Senda, M., Kasai, A., Sami, M., Ohta, Y., Kanda, T., & Ikeda, M. (2006). Dose-dependent hypocholesterolemic actions of dietary apple polyphenols in rat fed cholesterol. *Lipids, 41*, 133-139. Doi: 10.1007/s11745-006-5081-y.

Pudjiatmoko. (2008). Karakteristik apel Fuji. *Farming Japan*, 42-43.

Putri, G. N., Susanto, W. H., & Wijayanti, N. (2017). Pengaruh varietas apel Manalagi (*Malus sylvestris mill*) dan konsentrasi maizena terhadap karakteristik lempok apel. *Jurnal Pangan dan Agroindustri, 2*, 12-22.

Pyo, Y. H., Jin, Y. J., & Hwang, J. Y. (2014). Comparison of the effect of blending and juicing on the phytochemicals contents and antioxidant capacity of typical Korean kernel fruit juices. *Prev Nutr Food Sci, 19*(2), 108-114.

Ravn-Haren, G., Dragsted, L. O., Buch-Andersen, T., Jensen, E. N., Jensen, R. I., Nemeth-Balogh, M., Paulovicsová, B., Bergström, A., Wilcks, A., Licht, T. R., Markowski, J., & Bügel, S. (2013). Intake of whole apples or clear apple juice has contrasting effects on plasma lipids in healthy volunteers. *Eur Journal Nutr, 52*(8), 1875-1889. https://doi.org/10.1007/s00394-012-0489-z

Reimer, R. A., Grover, G. J., Koetzner, L., Gahler, R. J., Lyon, M. R., & Wood, S. (2011). The soluble fiber complex polyGlycopleX lowers serum triglycerides and reduces hepatic steatosis in high-sucrose-fed rats. *Nutrition Research*, *31*, 296-301. https://doi.org/10.1016/j.nutres.2011.03.12

Rembang, A. A., Rampengan, J. J. V., & Supit, S. (2015). *Pengaruh senam Zumba terhadap kadar trigliserida darah pada mahasiswa Fakultas Kedokteran Universitas Sam Ratulangi.* Fakultas Kedokteran Universitas Sama Ratulangi.

Ronghua, Y., & Barouch, L. A. (2007). Leptin signaling and obesity: Cardiovascular consequences. *Circulation Research*, *101*, 545-559. https://doi.org/10.1161/CIRCRESAHA.107.156596

Semenkovich, C. F., Goldberg, A. C., & Goldberg, I. J. (2011). *Disorder of lipid metabolism*. Elsevier Saunders.

Sugiyama, H., Akazome, Y., Shoji, T., Yamaguchi, A., Yasue, M., Kanda, T., & Ohtake, Y. (2007). Oligomeric procyanidins in apples polyphenol are main active component for inhibition of pancreatic lipase and triglyceride absorption. *Journal Agric. Food. Chem*, *55*, 4604-4609.

Sumarwan, U. (2011). *Perilaku konsumen: teori dan penerapannya dalam pemasaran.* PT. Ghalia Indonesia.

Thilakaranthna, S. H., Rupasinghe, H. P. V., & Needs, P. W. (2013). Apple peel bioactive rich extracts effectively inhibits in vitro human LDL cholesterol oxidation. *Food Chem*, *138*, 463-470. Doi: 10.1016/j.foodchem.2012.09.121.

The George Institute for Global Health. (2017). Reducing the burden of cardiovascular disease in Indonesia. *Evidence Review*, 25.

Tsao, R., Yang, R., Christopher, J., & Zhu, H. H. (2003). Polyphenolic profiles in eight apple cultivars using high-performance liquid chromatography (HPLC). *Journal of Agric. Food Chem.*, *51*, 6347-6353.

U.S. Department of Agriculture. (2005). *Dietary reference intake for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids.* https://www.nal.usda.gov/sites/default/files/fnic_uploads/Ch7_75-88.pdf

Vidal, R., Hernandez-Vallejo, S., Pauquai, T., Texier, O., Rousset, M., Chambaz, J., Demignot, S., & Lecorte, J. M. (2005). Apple procyanidins decrease cholesterol esterification and lipoprotein secretion in Caco-2/TC7 enterocytes. *Journal Lipid Res*, *46*, 258-268. Doi: 10.1194/jlr.M400209-JLR200.

Vrhovsek, U., Rigo, A., Tonon, D., & Mattivi, F. (2004). Quantitation of polyphenols in different apple varities. *Journal of Agric. Food. Chem*, *52*, 6532-6538.

WHO. (2011). *Global atlas on cardiovasclular disease prevention and control*. WHO (World Health Organization).

WHO. (2018). *Cardiovascular disease*. WHO (World Health Organization).

Wibawa, P. (2009). *Gambaran pemeriksaan kadar trigliserida pada mahasiswa semester IV Diploma III Analis Kesehatan Fikkes Universitas Muhammadiyah Semarang.* Fakultas Ilmu Keperawatan dan Kesehatan Universitas Muhammadiyah Semarang.

Wibowo, T. (2009). *Pengaruh pemberian seduhan kelopak Rosela (Hibiscus Sabdariffa) terhadap kadar trigliserida darah tikus putih (Rattus Norvegicus).* Fakultas Kedokteran Universitas Sebelas Maret.

Wojdylo, A., Oszmianski, J., & Laskowski, P. (2008). Polyphenolic compounds and antoxidant activity of new and old apple varities. *Journal of Agric. Food. Chem*, *56*, 6520-6530.

Wolfe, K., Wu, X., Liu, R.H. (2003). Antioxidant Activity of Apple Peels. *Journal of Agricultural and Food Chemistry*, *51*, 609-614. https://doi.org/10.1021/jf020782a

Wong, J. M., Eshafani, A., Singh, N., Villa, C. R., Mirrahimi, A., Jenkins, D. J., & Kendal, C. W. (2012). Gut microbiota, diet, and heart disease. *Journal AOAC Int*., *95*, 24-30.

Yao, N., He, R. R., Zeng, X. H., Huang, X. J., Du, T. L., Cui, J. C., & Hiroshi, K. (2014). Hypotriglyceridemic effect of apple polyphenols extract via up-regulation of lipoprotein lipase in triton WR-1339-induced mice. *Chin. Journal Integr. Med.*, *20*, 31-35.

Yap, H. C., Kui, K. L., Kai, H. Y., Sheung, W. L., Hiu, T. C., Sidney, T., Xiao, O. S., Chu, P. L., & Hung, F. T. (2007). Isoflavone intake in person at high risk of cardiovascular events: Implications for vascular endothelial function and the carotid atherosclerosis burden. *The American Journal of Clinical Nutrition, 86*(4), 938-945. https://doi.org/10.1093/ajcn/86.4.938