Original Article:

Consumption of Fruit Before Meals with Different Glycaemic Index to Lipid Profile and Blood Glucose Levels in Overweight Adults

Neldawati Ningrum[1], Dono Indarto[2], Suminah[3]

Abstract

***Background**:* Overweight increase the risk of non-communicable diseases. Lack of vegetables and fruit intake, and high consumption of sweet, fatty, and fried foods can increase the risk of overweight. Fruit contains high fiber and active compounds useful for controlling lipid profiles and blood glucose control. ***Objective**:* To identify the effect of consuming fruit before meals with different glycaemic index (GI) on lipid profiles and fasting blood glucose (FBG) levels in overweight adults. ***Methods**:* This experimental research used a pre-post control group design. The participants in this study were 43 overweight adults who were divided into 4 groups, control group, high GI group, moderate GI group, and low GI group. Each treatment group was given fruit with a different GI for 21 days. Measurement of lipid profile and blood glucose was done 3 times on day-1, day-14, and day-21. ***Results**:* Consumption of fruit before eating with low GI for 21 days reduced 14.56 mg/dl cholesterol, 30.4 mg/dl triglycerides, 23.55 mg/dl LDL, and 22.33 ml/dl FBG. The fruit intervention with low GI also increased 3.89 mg/dl HDL. ***Conclusion**:* Consumption of fruit with low GI before meals can help control lipid profile and FBG.

Keywords: Fruit, Overweight, Lipid Profile, Blood Glucose

International Journal of Human and Health Sciences Vol. 06 No. 03 July'22 Page :320-327
DOI: http://dx.doi.org/10.31344/ijhhs.v6i3.466

Introduction

Overweight increases the risk of non-communicable diseases[1] . Data in 2018 Basic Health Research showed that prevalence of overweight in adults >18 years in 2018 was 13.6%, this figure increased compared to 2013 which was 11.5%. Prevalence of obesity in Indonesia in the same age category is 21.8%, this prevalence has increased compared to 2013 which was 13.6%. Prevalence of overweight >18 years in Riau Province in 2018 was 14.0% and the prevalence of obesity in the same age category was 24.1%[2] . Overweight prevalence in Riau Province is higher than National overweight prevalence, research on causes and prevention of overweight is needed to find solutions to overweight problem in Riau Province. Percentage of obesity aged >15 years in Indragiri Hilir Regency in 2017 was 14.6%, which was 556 people from 38,113 visitors of Public Health Center and its network[3] .

Excessive consumption of fatty foods and low consumption of fruits and vegetables is one of causes of fat accumulation that results in overweight[1]

The average consumption of fruit and vegetables in Indonesia is still far from WHO recommendation for fruit and vegetable consumption, which is at least 5 servings per day. Proportion of Indonesian people aged >5 years who consume less vegetables and fruit (<5 servings per day a week) is 95.4%[2.] Accumulation of fat cells can increase insulin resistance and increase blood glucose[4]. Central

1. Postgraduate Program of Nutrition Sciences, Universitas Sebelas Maret Surakarta, Indonesia
2. Biomedical Laboratory and Department of Physiology, Faculty of Medicine, Universitas Sebelas Maret Surakarta Indonesia
3. Department of Agricultural Extension and Communication, Universitas Sebelas Maret Surakarta Indonesia

Correspondence to: Neldawati Ningrum, Postgraduate Program of Nutrition Sciences, Universitas Sebelas Maret Surakarta, Indonesia, E-mail : neldawatiningrum@gmail.com

fat accumulation and increased of triglycerides often occur in overweight individuals and are one of the causes of prediabetes[1,5]. Increased blood glucose and decreased insulin function can increase sensitive lipase hormone which will cause lipolysis resulting in release of fatty acids and glycerol into the blood circulation. That situation can increase free fatty acids, excess amounts will be metabolized in the liver and converted into phospholipids, cholesterol and triglycerides resulting in an increase in cholesterol and triglycerides which are then transported to the circulation via lipoproteins (LDL and HDL). The results of Yanti's study (2020) showed that 40.6% of patients with a high lipid profile had excessive carbohydrate intake. The OR value showed a high lipid profile 2.96 times caused by excessive carbohydrate intake[6].

Body weight (BW) control can be one of solution to control lipid profiles and blood glucose. A study in 2020 showed that a 5% reduction in BW could improve cell function and insulin sensitivity in liver and skeletal muscle cells in prediabetes and T2DM[4]. Standard of Nutritional Status by Ministry of Health in 2013 showed that an individual is categorized as overweight if the BMI measurement results are between 25.0-27.0. Measurement of body mass index (BMI) is one of the simple methods to monitor the nutritional status of adults (age >19), especially those related to underweight and overweight. BMI is known as a skeletal index which is an anthropometry to assess body mass consisting of bone, muscle and fat[1].

Increased high fiber intake can reduce the risk of being overweight. High intake of fiber and foods with high water content delay the rate of gastric emptying and digestion thereby slowing absorption, retard rate of glucose absorption, lowers plasma insulin levels, and causes a faster and long lasting feeling of fullness, thereby reducing total calorie intake[7]. Fruit has a glycaemic index (GI) which is associated with the rate of blood glucose rises. The glycaemic index is a number on a scale of 1-100 that describes the speed at which the carbohydrate content in a food ingredient is processed into glucose in the body[8]. The glycaemic index is divided into 3 categories, low GI (<55), medium GI (56-59), and high GI (>70). Fruits classified as low GI include oranges (oranges, grapefruit), pomegranates (apples, pears), bananas, berries (strawberries, grapes, kiwi), fresh dates, and peaches. Medium glycaemic index fruits are mango, papaya, honey pineapple, and longan. Fruits with a higher glycaemic index include ripe Ambon bananas, melons, cantaloupe and watermelon[9,10].

Fruit contains fiber which is resistant so it cannot be hydrolyzed by digestive enzymes. Fiber can hold water and form a thick liquid so that the digestive process in the stomach takes longer which provides a longer feeling of fullness which results in a decrease of total intake. Combination of dietary fiber intervention and exercise are effective in reducing excess fat tissue. This combination can also increase blood HDL levels[11]. American Diabetes Association (ADA) recommends consuming 25-30 grams of fiber per day[12]. Fruit is a food that contains active compounds (flavonoids and polyphenols) that work synergistically in carbohydrate, fat, and protein metabolism to reduce the risk of vascular complications[13] Bioactive compounds in fruit such as lycopene, anthocyanins, flavonoids and isoflavones can also affect lipid profiles which can be useful in reducing the risk of hyperlipidemia in obesity[14]. The results of Wati's research (2017) show that consumption of fruits and vegetables in smoothies form for 21 days can reduce 33 mg/dl total cholesterol levels[15].

Consume fruit before eating has the potential to increase satiety so that it can avoid larger food intakes, manipulate food sequences, and optimize glycaemic control[16]. Nagoro's research (2019) shows that consuming bananas and/or broccoli before meals can increase satiety and reduce 12.67 mg/dL fasting blood glucose (FBG) levels in healthy adults[17]. This research is in line with Fitri's research (2019) which showed that consuming fruit before eating is more effective at lowering FBG than consuming fruit after eating. The results of this study indicate that consumption of fruit before eating for 7 days can reduce 19.18 mg/dL FBG[18]. Hakim *et al*'s research (2019) recommends an interval between fruit consumption and eating between 30-120 minutes to maximize energy compensation from semisolid/solid preload[19].

Matherials and Methods

This research was a Randomized Controlled Trial (RCT) with the pre-post-tests control group design. Calculation of sample size used a hypothesis of formula test (Murti, 2013), based on the average of two independent populations from the different average of FBG levels in T2DM patients (Trico

et al) and 90 % power size. We obtained 9 participants of control or treatment group. The next calculation of sample size added 6.31 combined standard deviation from which derived from the mean difference of FBG levels between control and treatment groups in the Trico's study. We got 11 participants per group after adjusting with 20% loss of follow-up. People who lived in the area of Public Health Center Sungai Guntung, Kateman, Indragiri Hilir were eligible to participate in this study if they aged 25-50 years old and had 25-29.9 kg/m^2 BMI^2 while they excluded it if having a special diet and taking any drug for (BW) management. Selected research subjects were randomly divided into four groups: the control (C) group which only received nutrition education while the treatment (T) group received nutrition education and 100 g/day fruits with low GI (T1), moderate GI (T2) and high GI (T3) for 21 days. The research subjects consumed oranges and apples for T1 group, papaya and mango for the T2 group, and watermelon and melon for the T3 group before eating carbohydrates in each meal. This research protocol has been approved by the ethics committee of the Faculty of Medicine, Universitas Sebelas Maret, Surakarta No: 60/UN27.06.6.1/KEP/EC/2021.

Data of the characteristics of research subjects were obtained using questionnaires and followed by personal interviews. Anthropometric data measurements (BW, Height, and BMI) were carried out by researcher team at Public Health Center Sungai Guntung one week before the research began. Venous blood samples from research subjects were taken from their upper left arm at Raja Musa Hospital Laboratory, Indragiri Hilir. Furthermore, separated serum was sent to the Puri Husada Tembilahan Hospital District Laboratory in order to measure total cholesterol, triglycerides, Low Density Lipoprotein (LDL) and High Density Lipoprotein (HDL) and fasting blood glucose levels in the 1st, 14th, and 21st days intervention.

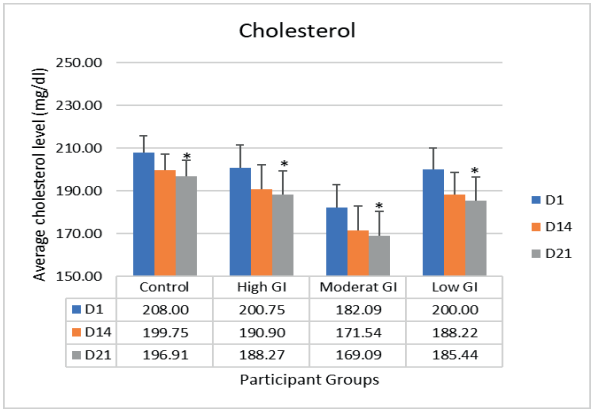
Data of research subject characteristics were presented as mean ± SD or number and percentage. The numeric data were statistically analyse using the anova test while the categorical data were analysed using chi square test. The mean differences of cholesterol total, TG, LDL, and FBG among groups were analysed using the repeated anova test whilw the mean different of HDL level used the friedman test. The significant value was set up <0.05.

Result

Characteristics of Participants

Table 1 showed that most participants are female (62.8%) with an average age of 30.00 ± 5.9 years. Most of participants graduated from Associate's degree (48.8%). A total of 67.4% of the participants were health workers and the rest of them were office workers, factory workers, drivers, housewives, and students. The average of BW was 67.80 ± 7.32 kg. The highest average BW was in the low GI group (70.01 ± 11.85 kg), while the lowest average weight was in control group (65.62 ± 5.27 kg). The average of height was 159.15 ± 7.51 cm. All participants were overweight adults with an average BMI of 26.72 ± 1.67 kg/m^2.

Effect of Consumption of Fruit Before Meals on Cholesterol Levels



	Control	High GI	Moderat GI	Low GI
D1	208.00	200.75	182.09	200.00
D14	199.75	190.90	171.54	188.22
D21	196.91	188.27	169.09	185.44

Figure 1. Effect of Consumption of Fruit Before Meals on Cholesterol Levels

*Anova Test (p < 0,05)

The blood cholesterol levels were examined three times, before treatment, on the 14th day, and the 21st day. The intervention group of High GI, Medium GI, and Low GI were given the intervention of fruit consumption with different glycaemic indexes for 21 days, while the control group did not receive it. A significant decrease in cholesterol levels occurred in each control and intervention group, but the most decrease occurred in the low GI group with 14.56 mg/dl (p = 0.001).

Effect of Consumption of Fruit Before Meals on Triglyceride Level High fruit intake could prevent hypertriglyceridemia effectively. However, evidence from practical relevance used the findings to devise nutritional recommendations

Table 1. Characteristic of Participants

	Participant Groups					p
	Control (C)	High GI (T3)	Moderate GI (T2)	Low GI (T1)	Total	
Gender						
Male	5 (41,7%)	4 (36,4%)	4 (36,4%)	3 (33,3%)	16 (37,2%)	
Female	7 (58,3%)	7 (63,6%)	7 (63,6%)	6 (66,7%)	27 (62,8%)	0,983
Total	12 (27,9%)	11 (25,6%)	11 (25,6%)	9 (20,9%)	43 (100%)	
Age	29,08 ± 6,25	30,00 ± 2,52	28,18 ± 4,19	35, 55 ± 7,74	30,00 ± 5,9	0,514
Education						
Senior high school	2 (16,7%)	1 (9,1%)	2 (18,2%)	2 (22,2%)	7 (16,3%)	0,661
Associate's degree	6 (50,0%)	7 (63,6%)	6 (54,5%)	2 (22,2%)	21 (48,8%)	
Bachelor degree	3 (25,0%	2 (18,2%)	3 (27,3%)	5 (55,6%)	13 (30,2%)	
Master degree	1 (8,3%)	1 (9,1%)	0 (0%)	0 (0%)	2 (4,7%)	
Total	12 (27,9%)	11 (25,8%)	11 (25,8%)	9 (20,9%)	43 (100%)	
Job						
Health worker	7 (58,3%)	8 (72,7%)	9 (81,8%)	5 (55,6%)	29 (67,4%)	0,495
Office worker	4 (33,3%)	2 (18,2%)	0 (0%)	2 (22,2%)	8 (18,6%)	
Factory workers	0 (0%)	0 (0%)	1 (9,1%)	1 (11,1%)	2 (4,7%)	
Student	0 (0%)	0 (0%)	1 (9,1 %)	0 (0%)	1 (2,3%)	
Housewives	0 (0%)	1 (9,1%)	0 (0%)	1 (11,1%)	2 (4,7%)	
Driver	1 (8,3%)	0 (0%)	0 (0%)	0 (0%)	1 (2,3%)	
Total	12 (27,9%)	11 (25,6%)	11 (25,6%)	9 (20,9%)	43 (100%)	
Weight	65,62±5,27	68,10±5,27	68,08±6,29	70,01±11,85	67,80±7,32	0,571
Height	158,39±6,28	160,50±5,97	157,24±5,59	160,87±12,13	159,15±7,51	0,345
BMI	26,12±1,14	26,42±1,40	27,55±2,29	26,89±1,51	26,72±1,67	0,496

would be limited, because of potential biases in cross-sectional studies. Total of trials that examined the effect of increasing fruit intake on the TG level was too limited [20] . Fig. 2 showed that there was no significant effect in both control and intervention groups who gave 1 serving of fruit per day However, this research showed the greatest decrease in the low GI group with 30.4 mg/dl.

Effect of Fruit Consumption Before Meals on Low Density Lipoprotein (LDL)

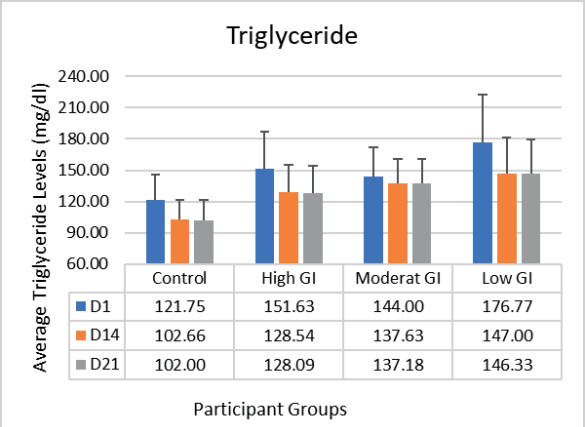


Figure 2 . The Effect of Consumption of Fruit Before Meals on Triglyceride Levels

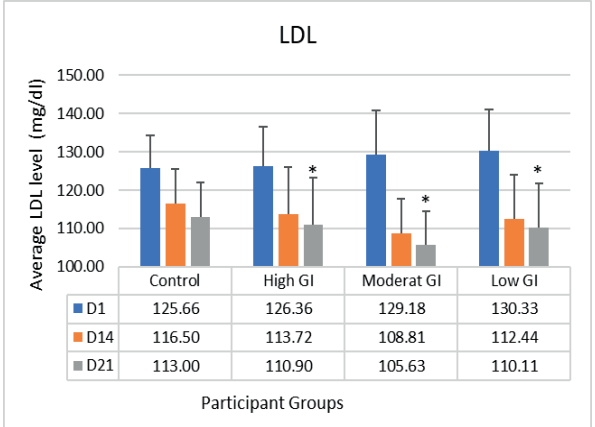


Figure 3. Effect of Consumption of Fruit Before Meals on LDL Levels

*Anova Test ($p < 0,05$)

A dietary pattern with greater intake of whole fruit and lower sweetened beverage intake was related to lower LDL[21]. Consuming high fruit and vegetable intake had the lowest risk of having a worse LDL status[22]. This research showed significant reduction in LDL levels occurred in each treatment group of high GI, medium GI, and low GI. The greatest decrease occurred in the moderate GI group with 23.55 mg/dl.

Effect of Fruit Consumption Before Meals on High Density Lipoprotein (HDL)

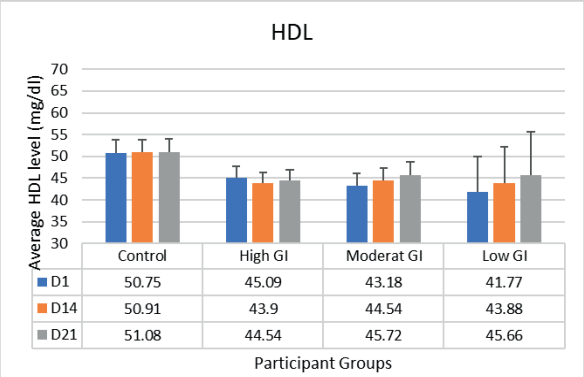


Figure 4 . Effect of Fruit Consumption Before Meals on HDL Levels

There was no significant effect in both control and intervention groups, but the highest increase occurred in the low GI group with 3.89 mg/dl. Consumption of fruit increased the vitamin C intake which was beneficial in cholesterol metabolism, namely lowering cholesterol and triglyceride levels and increasing High-Density Lipoprotein (HDL).

Effect of Fruit Consumption Before Meals on Fasting Blood Sugar (FBG)

Previous research found that dietary intake of total polyphenols and polyphenols from fruits have significant inverse relationship with blood glucose of. Lowest quartile of total polyphenols intake significantly associated ($p = 0.043$) with blood glucose. Higher intake of total flavonoids and flavonoids from fruits rather than other polyphenols subgroups was inversely associated with DM risk[23]. Fruits reduce blood glucose level attributed to two flavonoids known as naringin and neohesperidin. They increased insulin sensitivity within the cells and regulating liver enzymes known to facilitate glucose uptake regulation and increase liver efficiency[24].

This research showed that significant decrease in FBG levels occurs in the moderate GI group ($p = 0.001$) and low GI ($p = 0.001$), while the largest decrease occurs in the low GI group with 22.33 mg/dl. Consumption of fruits with a high GI value caused higher blood glucose and insulin response than consumption of foods with a low GI.

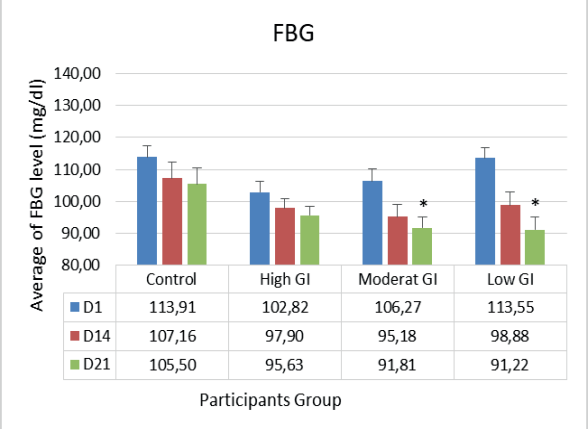


Figure 5. Effect of Consumption of Fruit Before Meals on Cholesterol Levels

***Anova Test ($p < 0,0$)**

Discussion

Effect of Consumption of Fruit Before Meals on Cholesterol Levels

Fruit had been one type of food which containing high fiber. When consuming fruit, mechanical and enzymatic digestion processes occurred in the oral cavity in which soluble and insoluble fiber contained in fruit does not decrease[25] .

Consumption of fruit before meals is expected to slow down gastric emptying and control intake, especially cholesterol intake. The American Diabetes Association (ADA) recommended to consume 25-30 grams of fiber per day. Regular consumption of fruits is recommended as they contain high fiber, vitamins, and bioactive substances that can help control lipid profile[12] .

Consumption of fiber from fruit helped increase levels of short-chain fatty acids (SCFAs), namely acetic acid, propionic acid, and butyric acid that help control fat levels in the blood. Consumption of fiber from fruit increased the enzymatic activity of cholesterol-7-α-hydroxylase which is the main enzyme of hepatic conversion of cholesterol to bile acids which function in the erosion of liver cholesterol. Vitamin C within fruits could inhibit

the activity of the HMG-CoA reductase which controls the cholesterol biosynthesis pathway in the liver and inhibits the formation of mevalonate so that inhibiting the formation of cholesterol. Vitamin C in fruits had been useful for helping hydroxylation reactions during the formation of bile acids which can increase cholesterol excretion[15]. Fruit contains flavonoids that can lower HMG-CoA reductase which can help lower cholesterol[9].

Effect of Consumption of Fruit Before Meals on Triglyceride Levels

The type of soluble fiber in fruit worked to form a thick solution that can prolong gastric emptying time, inhibits the transport of triglycerides, and cholesterol in the intestines, and reduces LDL concentrations. Therefore, regular fruit consumption expected to control triglyceride levels in the blood[26]. Maintaining triglyceride levels required a combination of fruit intake with a low glycaemic index and lower carbohydrate intake[27].

Regular consumption of fiber from fruits reduced triglyceride levels by 1.96% and oxidative stress so that it helps improve lipid profiles. Soluble fiber (pectin) and vitamin C could inhibit dietary fat absorption so that it has a protective effect on the lipid profile[28].

Effect of Fruit Consumption Before Meals on Low Density Lipoprotein (LDL)

A meta-analysis of 28 trials revealed that low GI foods do not affect HDL or triglyceride levels, but help lower LDL levels simply by increasing fiber consumption[29]. Another study found a decrease in LDL by 35.36 mg/dl after the intervention of fruit consumption and aerobic exercise for 14 days[30]. Fiber had resistance properties so that it cannot be hydrolyzed by digestive enzymes. Furthermore, fiber hold water and form a thick liquid so that the digestive process in the stomach takes longer which gives a feeling of fullness for longer which then reduces excess intake. Dietary fiber intervention with a combination of exercise was effective in reducing excess fat tissue. The combination also could increase blood HDL levels[30]. Consumption of fruits and vegetables helped to maintain a lipid profile within a normal range as they are both rich in phytosterols, fiber, and low in cholesterol[31]. The Victoria-Montesinos study (2021) with the intervention of a combination of citrus fruit flavonoids and olive leaf polyphenols for 3 months managed to reduce 8 mg/dl LDL-C in adults[32]. Furthermore, a study found that an average increase in fiber intake of 29.1 grams for 14 days can reduce low-density lipoprotein cholesterol (LDL) disamakan levels by 35.36 mg/dL[11].

Effect of Fruit Consumption Before Meals on High Density Lipoprotein (HDL)

Previous studies have revealed differences in HDL levels between before and after the treatment. The differences in HDL levels in the blood are caused by reduced fat intake, especially saturated fat. The effect of saturated fatty acids on lipoprotein metabolism was able to inhibit the work of the Lecithin cholesterol acyltransferase (LCAT) enzyme which could help remove cholesterol from lipoproteins and tissues[33]. Previous research showed an increase in HDL of 10.72 mg/dl in the elderly who consume fruit juice and perform exercise 3 times per week for 14 days[34]. Another study revealed an increase of 7 mg/dl in adults who consumed soursop fruit for 7 weeks[35].

Effect of Fruit Consumption Before Meals on Fasting Blood Sugar (FBG)

Fruits with a high GI was absorbed more quickly in the small intestine and have more potential to cause an increase in blood glucose compared to fruits with a lower GI[8,36]. This study indicated that regular fruit consumption over a longer period of time can reduce FBG more than previous studies which showed a decrease in FBG levels of ±18 mg/dl in patients with T2DM who consumed fresh fruit with moderate GI and low GI for 7 days[28]. Consumption of fruit with a high GI did not cause an increase in glucose fluctuations as the absorption process is different[37].

Conclusion

Consuming fruit before meals for 21 days can help optimize lipid profiles and blood glucose. Eating fruit with a low glycaemic index will control lipid profiles and blood glucose better than fruit with a medium and high glycaemic index. Based on

this study, it can be concluded that consuming fruit with a low glycaemic index before eating can help control lipid profiles and blood glucose in overweight adults. Consumption of fruit before eating with low GI for 21 days reduced 14.56 mg/dl cholesterol, 30.4 mg/dl triglycerides, 23.55 mg/dl LDL, and 22.33 ml/dl FBG. The fruit intervention with low GI also increased 3.89 mg/dl HDL.

Conflict of interest

None declare

Acknowledgement

The authors highly appreciate nutritionists and laboratory analyst at RSUD Raja Musa and Sungai Guntung Public Health Center who have assisted in this study.

Authors' contribution

Study design: Neldawati Ningrum, Dono Indarto, Suminah

Data gathering: Neldawati Ningrum

Writing and submitting manuscript: Neldawati Ningrum

Editing and approval of final draft: Neldawati Ningrum, Dono Indarto

Ethical clearance

This research protocol has been approved by the ethics committee of the Faculty of Medicine, Universitas Sebelas Maret, Surakarta No: 60/ UN27.06.6.1/KEP/EC/2021.

Source of Funding:

No Funding

References

1. Rakvaag, E. *et al.* Whey Protein Combined with Low Dietary Fiber Improves Lipid Profile in Subjects with Abdominal Obesity: A Randomized, Controlled Trial. *Nutrients* **11**, 1–18 (2019).
2. RISKESDAS. *Laporan Nasional Riskesdas 2018*. (2018).
3. Dinas Kesehatan Provinsi Riau. *Profil Kesehatan Provinsi Riau 2017*. *Dinas Kesehatan Provinsi Riau* vol. 7 (2018).
4. Wani, K. *et al.* Effects of a 12-month intensive lifestyle monitoring program in predominantly overweight/ obese arab adults with prediabetes. *Nutrients* **12**, 1–12 (2020).
5. Tabassum, M., Mozaffor, M., Rahman, M. M. & Huda, R. M. Triglycerides and Glucose Index as Potential Marker of Metabolic Syndrome. *Int. J. Hum. Heal. Sci.* **5**, 85 (2020).
6. Yanti, N. D., Suryana & Fitri, Y. Analisis Asupan Karbohidrat dan Lemak Serta Aktivitas Fisik terhadap Profil Lipid Darah pada Penderita Penyakit Jantung Koroner. *Aceh Nutr. J.* **2020**, 179–186 (2020).
7. Muscogiuri, G. *et al.* Patient Empowerment and The Mediterranean Diet as a Possible Tool to Tackle Prediabetes Associated with Overweight or Obesity: a pilot study. *Hormones* **18**, 75–84 (2019).
8. Astuti, A. & Maulani, M. Pangan Indeks Glikemik Tinggi Dan Glukosa Darah Pasien Diabetes Mellitus Tipe Ii. *J. Endur.* **2**, 225 (2017).
9. Alperet, D. J., Butler, L. M., Koh, W. P., Yuan, J. M. & Van Dam, R. M. Influence of Temperate, Subtropical, and Tropical Fruit Consumption on Risk of Type 2 Diabetes in an Asian Population. *Am. J. Clin. Nutr.* **105**, 736–745 (2017).
10. Zhou, X. *et al.* Fresh Fruit Intake in Pregnancy and Association with Gestational Diabetes Mellitus: A Prospective Cohort Study. *Nutrition* **60**, 129–135 (2019).
11. Maryusman, T., Imtihanah, S. & Firdausa, N. I. Kombinasi Diet Tinggi Serat dan Senam Aerobik terhadap Profil Lipid Darah pada Pasien Dislipidemia. *Gizi Indones.* **43**, 67–76 (2020).
12. Hartamin, Nurlinda, A. & Jafar, N. Pengaruh Konsumsi Buah Naga Merah terhadap Kadar Glukosa Darah Puasa pada Guru Sekolah Menengah yang Mengalami Prediabetes atau Prehipertensi di Makassar. *Nurs. Insid. Community* **2**, 86–93 (2020).
13. Du, H. *et al.* Fresh fruit consumption in relation to incident diabetes and diabetic vascular complications: A 7-y prospective study of 0.5 million Chinese adults. *PLoS Med.* **14**, 1–19 (2017).
14. Listianasari, Y., Dirgahayu, P., Wasita, B. & Patriadi, M. Efektivitas pemberian jus labu siam [Sechium edule] … (Listianasari Y; dkk). *Penelit. Gizi dan Makanan* **40**, 35–43 (2017).

15. Wati, W. A. An., Jaelani, M. & Sulistyowati, E. Pengaruh Smoothies Kombinasi Aneka Buah dan Sayur terhadap Penurunan Kadar Kolesterol Total. *J. Ris. Gizi* **7**, 1–15 (2019).
16. Umagapi, F. Pengaruh Konsumsi Buah Segar dan Jus Buah dengan Indeks Glikemik Sedang dan Tinggi Terhadap Kadar Glukosa Darah Puasa, Homa-β dan Short Chain Fatty Acids (SCFAs) Pada Pasien Diabetes Melitus Tipe 2. *Universitas Sebelas Maret* (2019).
17. Nagoro, D. S. Pengaruh Pisang dan atau Brokoli sebelum Makan Karbohidrat Terhadap Kadar Glukosa Darah, Lingkar Pinggang, dan Rasa Kenyang pada Guru. vol. 2 (Universitas Sebelas Maret Surakarta, 2018).
18. Fitri, N. Pengaruh Urutan Konsumsi Buah dengan Indeks Glikemik Rendah, Sedang, dan Tinggi terhadap Kadar Glukosa Darah Puasa, HOMA-β, dan Short-Chain Fatty Acids pada Pasien DM Tipe 2. (Universitas Sebelas Maret Surakarta, 2019).
19. Hakim, B. N. A., Yahya, H. M., Shahar, S., Manaf, Z. A. & Damanhuri, H. Effect of Sequence of Fruit Intake in a Meal on Satiety. *Int. J. Environ. Res. Public Health* **16**, (2019).
20. Kodama, S. *et al.* Relationship between Intake of Fruit Separately from Vegetables and Triglycerides - A meta-analysis. *Clin. Nutr. ESPEN* **27**, 53–58 (2018).
21. Mellendick, K. *et al.* Diets Rich in Fruits and Vegetables are Associated with Lower Cardiovascular Disease Risk in Adolescents. *Nutrients* **10**, (2018).
22. Chung, G. K. K., Yu, R. H. Y., Ho, S. S. Y., Woo, J. & Ho, S. C. Associations of Consuming Specific Fruit and Vegetable Subgroups with LDL-C Status in Early Postmenopausal Chinese Women. *Menopause* **25**, 436–443 (2018).
23. Gao, Q. *et al.* Inverse Association of Total Polyphenols and Flavonoids Intake and The Intake from Fruits with The Risk of Gestational Diabetes Mellitus: A Prospective Cohort Study. *Clin. Nutr.* **40**, 550–559 (2021).
24. Ani, P. N. & Aginam, P. C. Effect of Citrus Maxima juice on Fasting Blood Glucose, Lipid Profile, Liver Enzyme and Body Weight. *Nutr. Food Sci.* **48**, 755–763 (2018).
25. Mahan, L. K. & Raymond, J. L. *Krauses's : Food and The Nutrition Care Process*. (Elsevier, 2017).
26. Sima, P., Vannucci, L. & Vetvicka, V. β -glucans and cholesterol (Review). *Int. J. Mol. Med.* 1799–1808 (2018) doi:10.3892/ijmm.2018.3411.
27. Chiavaroli, L. *et al.* Effect of Low Glycaemic Index or Load Dietary Patterns on Glycaemic Control and Cardiometabolic Risk Factors in Diabetes: Systematic Review and Meta-analysis of Randomised Controlled Trials. *BMJ* **374**, (2021).
28. Pekerti, A. C., Nila, K. F. & Inggita, K. Jus Jambu Merah dan Jeruk Siam Menurunkan Trigliserida pada Wanita Dislipidemia. *Indones. J. Hum. Nutr.* **6**, 1–9 (2019).
29. Liu, Y., Sun, P., Shuai, P., Qiao, Q. & Li, T. Fat-restricted low-glycemic index diet controls weight and improves blood lipid profile. *Medicine (Baltimore).* **100**, e26107 (2021).
30. Maryusman, T., Imtihanah, S. & Firdausa, N. I. Kombinasi Diet Tinggi Serat dan Senam Aerobik terhadap Profil Lipid Darah pada Pasien Dislipidemia. *Gizi Indones.* **43**, 67–76 (2020).
31. Wojda, A., Janczy, A. & Małgorzewicz, S. Mediterranean, Vegetarian and Vegan Diets as Practical Outtakes of EAS and ACC/AHA Recommendations for Lowering Lipid Profile. *Acta Biochim. Pol.* **68**, 41–48 (2021).
32. Victoria-Montesinos, D. *et al.* Effectiveness of Consumption of a Combination of Citrus fruit Flavonoids and Olive Leaf Polyphenols to Reduce Oxidation of Low Density Lipoprotein in Treatment-Naïve Cardiovascular Risk Subjects: A Randomized Double-blind Controlled Study. *Antioxidants* **10**, 1–10 (2021).
33. Dalimunte, N. A. & Rahman, S. Efek Jus Buah Jambu Biji Merah (Psidium Guajava L.) Terhadap Kadar Kolesterol LDL Pada Serum. *J. Pandu Husada* **1**, 239 (2020).
34. Khotimah, K., Anantanyu, S., Wiboworini, B. & Hanim, D. Pengaruh Jus Buah Naga Merah dan Senam terhadap Kadar Hdl Lansia. *J. Kesehat. Kusuma Husada* 213–219 (2018) doi:10.34035/jk.v9i2.282.
35. Alatas, H. Pengaruh Buah Sirsak Terhadap Faktor Risiko Kardiovaskular (Kolesterol Total, HDL, LDL, Trigliserida). *Herb-Medicine J.* **4**, 1 (2021).
36. Anita, D. C. & Prihatiningsih, D. Correspondence to : Diyah Candra Anita , Nursing Study Program Faculty of Health Sciences , ' Aisyiyah University of Yogyakarta , Indonesia , E-mail : diyah.candra@gmail.com. **03**, 207–217 (2018).
37. Shao, S. ying *et al.* Glycemic Index, Glycemic Load, and Glycemic Response to Pomelo in Patients with Type 2 Diabetes. *J. Huazhong Univ. Sci. Technol. - Med. Sci.* **37**, 711–718 (2017).