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Effect of tomato and red guava juice on blood glucose level in overweight woman

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ABSTRACT

Background: Based on the results of Riskesdas 2018 that the prevalence of diabetes mellitus in Indonesia showed an increase from 6.9% to 8.5%. Overweight is closely related to impaired blood glucose, insulin resistance, and decreased insulin secretion. Preventive efforts that have been made using non-pharmacological treatments, such as increasing the intake of fiber and lycopene from fruits.
Objectives: This study aimed to determine the effect of tomato juice and guava juice on blood glucose levels in overweight women.
Materials and Methods: The study design is a true experiment conducted in 11subjects in treatment group and 11 subjects in control group. The subject of this study were overweight adult women 45-55 years. Blood sampling was taken in the morning, then glucose levels were measured using the GOD-PAP method (Glucose Para Amino Phenazone). We gave 600 ml of tomato juice and red guava every day for 21 days. To find the effect of juice on fasting blood glucose levels controlled by nutrient intake and physical exercise using the Repeated Measure ANOVA test.
Results: In the treatment group, there was a decrease of 3.24 mg/dl in blood glucose levels; while, in the control group, the decrease in blood glucose levels was only 0.26 mg/dl. However, we found no statistically significant differences in both groups.
Conclusions: Consumption of tomato juice and red guava reduced fasting blood glucose.

Keyword: Blood glucose; Tomato; Red guava; Women; Overweight

BACKGROUND

At the age of 45, people experience an increased risk of developing diabetes and glucose intolerance due to decreased ability of beta cells to produce insulin whose function is to metabolize glucose[1]. Females are more prone to diabetes due to estrogen. As estrogen decreases, insulin resistance begins to arise which causes an increase in blood glucose[2]. Overweight is closely related to several conditions, including impaired blood glucose, disrupted balance of glucose and insulin, and decreased insulin metabolism. Obesity causes an increase in fatty acids or Free Fatty Acid (FFA) in cells and this could lead to insulin resistance[3].

People suffering from DM will depend on drugs throughout their life. Anti-hyperglycemia drugs cause side effects such as nausea, weight gain, diarrhea, and bloated stomach which lead to non-adherence medication[4]. Therefore, we need an alternative that does not have side effects, which is by utilizing fruit with a low glycemic index. Fruit is a safe alternative because it is part of the diet.

Tomato contains an active substance called lycopene. Lycopene is an antioxidant whose ability is to resist free radicals. Lycopene can lower blood glucose by reducing insulin resistance, leading to cell tolerance to glucose increases, and excess blood sugar levels can be overcome[2].

Red guava is a fruit with high vitamin C content and pectin-type fiber. Pectin is hypoglycemic which can reduce blood glucose levels as pectin plays a role in the formation of gels in the gastrointestinal tract. Vitamin C plays a role in reducing glucose toxicity, thereby preventing a decrease in β cell mass and insulin level.

In this research, 300 grams of tomatoes and 300 grams of red guavas were processed into juice. This combination is expected to reduce blood glucose levels in overweight females aged 45 - 55 years.

MATERIALS AND METHODS

This research implemented a true experimental design with randomized pre-test and

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post-test control group design. It was conducted in RW 02 Pedurungan Tengah, Semarang. The research subjects were grouped randomly. The sample size was calculated using the hypothesis test formula on two independent groups, obtaining 11 subjects in the treatment group and 11 subjects in the control group. The subjects involved were females aged 45-55 years with a BMI ≥ of 23 kg/m^2, not taking medication, and had never been diagnosed by a doctor with diabetes mellitus. This study has been approved by Health Research Ethics Committee of Health Polytechnic of Semarang Number 113/EA/KEPK2019.

The subjects in the treatment group had their blood glucose levels measured before and after giving tomato and red guava juices. While the subjects in the control group had their blood glucose levels measured, but not receiving tomato and red guava juices. Blood sampling was carried out in the morning after the subjects were asked to fast for 8 hours. Measurement of fasting blood glucose levels was done using the GOD-PAP method (Glucose Oxidase Para Amino Phenazone). The research variables included the independent variable of tomato and red guava juice provision. Tomatoes and red guavas, each at 300 grams, were juiced together by adding 150 ml of water. The treatment group was then given the juice to consume 2 times a day, in the morning and evening, with each administration of 300 ml for 21 days. The dependent variable was fasting blood glucose.

The instruments used consisted of sample identity form, data collection form to record food intakes, product acceptability test form, juice consumption adherence form, and physical exercise form. To measure food intakes, the 2 x 24-hour food recall method was used to determine energy and carbohydrate intakes. Meanwhile, a food frequency questionnaire (FFQ) was used to determine fiber, vitamin C, and lycopene intakes. Juice consumption adherence was measured by asking the subjects how much juice was consumed. Microtoice was used for height measurement and digital weighing was used for weight measurement. To determine the effect of tomato and guava juice on fasting blood glucose levels before and after the research, and analysis was performed using the Repeated Measure ANOVA test, with $\alpha = 0.05$.

RESULTS

Table 1 shows that the research subjects were aged between 45 - 55 years. The average BMI in the treatment group was 28.26 kg/m^2 and the control group was 29.2 kg/m^2. The average fasting blood glucose levels in the treatment and control groups before treatments were 84.77 mg/dl and 85.66 mg/dl, respectively. The average fasting blood glucose levels after treatments in the treatment and control groups were 81.53 mg/dl and 85.4 mg/dl, respectively. The average energy adequacy levels in the treatment and control groups were 69.12% and 52.81%, carbohydrate intakes were 54.53% and 42.2%, fiber intakes were 10.55 g and 8.08 g, lycopene intakes were 2.42 μg and 1.21 μg, and vitamin C intakes were 57.92 mg and 45.98 mg.

Table 1. Research Subject Characteristics

Variable	*Treatment*			Control			
	Mean±SD	*Min*	*Max*	*Mean±SD*	*Min*	*Max*	*P-value*
Age	49.67±3.24	45	55	50.67±3.96	45	55	0.29
BMI	28.26±3.76	23.1	34.7	29.22±4.3	23.1	35.3	0.57
Initial GDP	84.77±13.11	63.6	103.5	85.66±13.67	66.3	114.0	0.86
Final GDP	81.53±11.46	63.6	104.0	85.4±6.66	72.5	92.6	0.31
Energy (%)	69.12±25.69	26.6	117.8	52.81±19.1	28.5	91.2	0.47
Carbohydrate (%)	54.53±20.32	25.2	90.2	42.2±13.1	28.5	91.2	0.41
Fiber (g)	10.55±2.98	4.8	14.1	8.08±2.25	4.8	11.8	0.47
Lycopene (μg)	2.42±1.04	0.8	4.2	1.21±0.51	0.8	2.5	0.10
Vit C (mg)	57.92±15.4	34.8	78.9	45.98±9.55	34.7	60.9	0.10

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Table 2. Differences in Blood Glucose Levels between Treatment and Control Groups

	Between Treatment *Mean ±SD*	After Treatment *Mean ±SD*	Difference	P-value
Control group	85.66 ± 13.67	85.40 ± 6.66	-0.26	0.533
Treatment group	84.77 ± 13.11	81.53 ± 11.46	-3.24 ± 6.85	0.438

Based on the results of analysis presented in table 2, there was a decrease in fasting blood glucose levels for subjects in the treatment group by 3.24 mg/dl and in the control group by 0.26 mg/dl. The statistical test on the difference in decreased fasting blood glucose levels obtained a p-value of 0.438 in the treatment group and a p-value of 0.533 in the control group. Therefore, it can be concluded that there is no difference in fasting blood glucose levels between the treatment and control groups before and after treatments. It is in line with research conducted by Widyasulistya (2018) where there was no significant difference between blood glucose levels before and after treatments of giving guava juice for 3 days to football athletes[5].

Table 3. Repeated Measure ANOVA Multivariate Test

Variable	P-value
Kec_Energy	0.299
Kec_Carbohydrate	0.472
Kec_Fiber	0.370
Kec_VitC	0.293
Groups	0.521

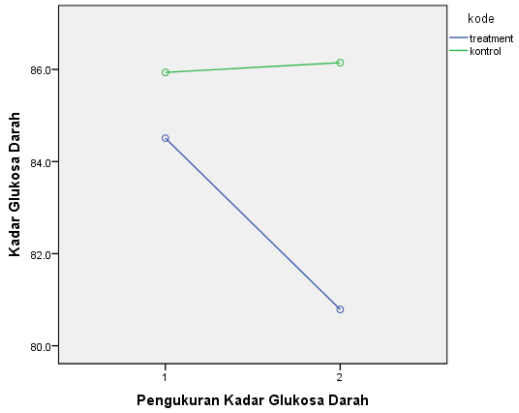

Figure 1. The difference in Fasting Blood Glucose Levels between Treatment and Control Groups

This test's results showed that there was no significant difference (p = 0.521) in blood glucose levels between the treatment group and the control group, although clinically there was a decrease in blood glucose levels in the treatment group by 3.24 mg/dl. Meanwhile, the level of adequate energy, carbohydrate, fiber, and vitamin C did not affect changes in blood glucose levels. As shown in Figure 1, there was a decrease in the treatment group after being given tomato and guava juice.

DISCUSSION

Tomato and red guava juices were given 2 times a day, in the morning and evening, as much as 300 ml per administration. This mixed juice contains soluble fiber such as pectin, lycopene, and vitamin C, with each contribution of 96% of lycopene, 78% of fiber, and 121% of vitamin C. The analysis showed that there was no effect of giving tomato and red guava juices on blood glucose levels in overweight adult females aged 45-55 years (p = 0.521). The level of energy, carbohydrate, fiber, and vitamin C intakes did not

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statistically have a significant effect on changes in blood glucose levels. The results of this research are in line with that of Ayuhapsari et al (2018) where they found that energy, carbohydrate, and fiber intakes did not affect changes in fasting blood glucose[6].

A factor that resulted in the non-significant effect of treatments in this research was the age of the subjects over 45 years. At that age, there will be an increase in blood glucose due to changes in pancreatic beta cells that produce insulin, resulting in a decreased insulin production. The decrease in insulin production results in a reduced amount of glucose that enters cells, so glucose remains in the blood vessels and causes increased blood glucose level[2].

The nutritional status of research subjects could cause less effective effects of treatments, with the research subjects' average BMI of 28.26 kg/m^2 included in the category of obesity level I. Obesity is related to conditions of impaired blood glucose, disrupted balance in glucose and insulin, and decreased insulin metabolism[3].

As seen in Table 1, the average fasting blood glucose levels before treatments in the treatment group were 84.77 mg/dl, and after treatments were 81.53 mg/dl. It showed a decrease of 3.24 mg/dl, but the decrease was still in the category of normal blood glucose level. Whereas in the control group the average fasting blood glucose levels were 85.66 mg/dl and went down to 85.40 mg/dl. There was only a decrease of 0.26 mg/dl. This showed that consumption of 600 ml of tomato and red guava juice for 21 days could reduce blood glucose levels by 3.24 mg/dl and/or maintain blood glucose levels in the normal category.

Changes in fasting blood glucose levels between the treatment and the control groups could be caused by the consumption of tomato and red guava juice. Tomato contains lycopene whose function is anti-diabetic by increasing the concentration of insulin[2]. Lycopene can lower blood glucose levels by inhibiting glucose absorption in the intestine, increasing glucose transport in the blood, stimulating glycogen synthesis, and inhibiting glucose synthesis. Lycopene prevents degenerative diseases such as diabetes through an oxidative mechanism. Lycopene binds to reactive oxygen and increases antioxidant potency, thereby reducing oxidative damage to lipids. Meanwhile, the non-oxidative mechanism of lycopene is done through gene function which improves gap-junction communication, hormone modulation, and immune response, all of which can reduce degenerative diseases such as DM[7].

Research conducted by Astuti and R (2018) revealed that provision of tomato juice to blood glucose levels in pre-diabetes as much as 200 ml for 21 days showed a decrease in blood glucose by 9.00 mg/dl[2]. Another research conducted by Yusni (2015) showed that the administration of tomato extract and mangosteen extract to diabetic mice each 50 mg/kg bb/day for seven days showed a decrease in blood glucose levels by 56.67%[7]. Research by Chairunnisa (2012) was conducted by giving tomato paste to diabetic mice as much as 62 mg for 7 days reduced blood glucose levels by 262 mg/dl with a decreasing percentage reaching 75.60%[8]. Another research conducted by Wuryaningrum (2016) on giving 250 ml of rainbow smoothies to type 2 DM patients for 10 days showed statistically significant results and decreased blood glucose levels by 43.75 mg/dl[9].

Changes in fasting blood glucose levels could be caused because of guava consumption. Guava contains water-soluble fiber, such as pectin, and vitamin C. Pectin can reduce blood glucose levels because it is hypoglycemic and its physiological function is to increase glucose tolerance in people suffering from DM[10]. Pectin plays a role in gel formation because there is a reaction of fiber with water in the gastrointestinal tract. This gel will slow down gastric emptying and the movement of food through the upper gastrointestinal tract and inhibit the mixing of the gastrointestinal contents with digestive enzymes so that there is a reduction in the absorption of nutrients in the proximal part. This inhibition affects the slow absorption of glucose, causing a decrease in blood glucose[11,12]. Pectin can envelop carbohydrate molecules so that they inhibit carbohydrate absorption and will be released slowly so that the amount of sugar that enters the blood is reduced and an increase in excess blood glucose levels can be avoided[13].

Vitamin C contained in red guava is higher than in orange, which is at 49 mg per 100 grams[14]. Vitamin C can increase insulin sensitivity and lower blood glucose levels by reducing glucose toxicity, preventing decreased beta-cell mass, and increasing the amount of insulin. These three mechanisms of vitamin C protect against organ damage in diabetes: vitamin C as an antioxidant, vitamin C inhibits intracellular sorbitol

accumulation, vitamin C reduces protein glycosylation[15].

Vitamin C plays a role in modulating insulin action in people suffering from diabetes and is associated with lowering blood glucose levels. Vitamin C can inhibit the accumulation of sorbitol caused by hyperglycemia through the polyol-sorbitol pathway. Vitamin C acts as an inhibitor of the aldolase reductase enzyme which converts glucose in cells into sorbitol, so it can prevent sorbitol buildup and reduce oxidative stress and improve endothelial function. The buildup of sorbitol in cells or tissues can cause damage or change in functions[16,17]. Research conducted by Santi (2013) revealed that the provision of red guava juice as much as 2 gr/head/day for 10 days to hyperglycemic mice resulted in decreased blood glucose levels by 164.5 gr/dl[13].

CONCLUSIONS

Consumption of tomato and red guava juice did not significantly reduce blood glucose levels, with a p-value > 0.05. Consumption of tomato and guava juice can be used as part of a daily diet to control blood sugar within the normal range.

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