The Impact of Tomato Juice on Reducing Blood Sugar Levels at Diabetes Mellitus Patients

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Abstract: The number of people with Diabetes Mellitus (DM) is estimated by WHO will continue to increase until 21.3 million in 2030, DM is a disease ranked 3 out of the top 10 diseases in Indonesia, where every year the population continues to increase due to changes in people's lifestyles, especially living in the city. This study used quasi-experimental research design with equivalent time sample design. The method was giving treatment to the first sample, while the second sample did not need to be treated. Then both samples are observed repeatedly. The sample technique used positive sampling. Statistical test results from the Wilcoxon test of the treatment group obtained p value = 0,002 < α = 0.05 , which means that there was an effect of tomato juice giving to decrease blood sugar levels. The study results can provide input for nurses in providing services to diabetes mellitus patients in the community that the tomato juice utilization is one of the efforts in reducing blood sugar levels without consuming pharmacological therapy

1 INTRODUCTION

Indonesia is the fourth most diabetic country in the world after India, China and United States. This number will certainly continue grow from year to year, if many people do not change their lifestyle even, according to Dr. R. Bowo Pramono, Sp, Pd. KEMD (K), more than 60 percent of Indonesia's population is unaware that they have diabetes, as quoted on dikti.go.id. The number of people with Diabetes Mellitus (DM) is estimated by WHO will continue to increase until 21.3 million in 2030, DM is a disease ranked 3 out of the top 10 diseases in Indonesia, where every year the population continues to increase due to changes in people's lifestyles, especially who live in the city (Lamongan Regency in 2018). According to Riskesdas in 2013, the prevalence of Diabetes Mellitus in Indonesia based on the answers that ever diagnosed by doctors was 1.5%. Diabetes Mellitus is based on diagnosis with symptoms of 2.1%. The prevalence of diabetes mellitus in women tends to be higher than in men.

Diabetes Mellitus patients have a risk of the disease developing; they have twice the risk of having coronary heart disease, five times more susceptible to gangrene, seven times more susceptible to kidney failure, and 25 times more susceptible to retinal damage resulting in blindness in Type 2 Diabetes Mellitus patients than non Diabetes Mellitus patients (Waspadji, 2007).

Dietary settings for diabetics, it is recommended to pay attention to carbohydrate and fiber intake because it is important in controlling blood glucose levels. In fact, diabetics who have run a diet program are apparently not able to control good blood glucose so that their daily blood sugar levels remain high. The reason is the lack of intake of fruits and vegetables as a source of fiber in the body, healthy food is believed to prevent and control diabetes such as foods high in fiber e.g. fruits, vegetables, nuts and seeds. Besides that, fruit is an excellent source of antioxidants. Antioxidants themselves play an important role to help avoid cell damage due to the oxidation stress which is often associated with various diabetes complications. According to Sutedjo, 2010, the complications occurrence in Diabetes Mellitus will endanger the sufferer and reduce the quality of life. Complications can occur in the condition "blood sugar levels when uncontrolled for a long time". So Diabetes Mellitus patients with high blood sugar levels continuously and have suffered more than 10 years, can be confirmed will suffer complications.

Diabetes Mellitus Complications are often called "The Great Imitator" because it can affect all

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organs of the body. They are grouped into two, namely: acute and chronic complications. As for acute complications in diabetes mellitus patients: Hypoglycemia, is a serious complication in the management of Type 2 diabetes mellitus, especially elderly Diabetes Mellitus patients, patients with renal insufficiency, and patients with severe micro or macroangiopathy disorders. Efforts to prevent complications require heavy blood sugar control to be close to normal, while the result of severe blood sugar control is the risk of hypoglycemia that is getting heavier. Causes of hypoglycemia: excessive exercise than usual, excessive doses of diabetes medication, improper eating schedule with diabetes medications taken, eliminating or not spending food or snacks, drink alcohol, never being in control so that the medicine given is not the right dose. Diabetes ketoacidosis (DKA) is a severe and acute insulin deficiency from Diabetes Mellitus illness. Diagnosis criteria of DKA are polyuria, polydipsia, nausea and / or vomiting, Kussmaul breathing (deep and frequent), weakness, dehydration, hypotension to shock, disturbed consciousness to coma, hyperglycemia more than 300 mg / dL (usually exceeds 500 mg / dL). Bikarbornat less than 20 mEq / l and pH <7.35 (metabolic acidosis), ketonemia, glucosuria, ketonuria, severe dehydration, hypotension until hypovolemic shock, neurological symptoms are obtained, definitive diagnosis is made when there are clinical symptoms coupled with blood osmolarity> 325 -350 mOSM / l. It is usually develop gradually for chronic complications in diabetes mellitus patients and it is occur when diabetes is not well managed. High blood sugar levels that are not controlled from time to time will increase the complications risk, namely serious damage to organs such as: microcirculation disorders with all its effects, disturbances of the respiratory system both central, autonomous, and edge, interference with the eye senses both the cornea, lens, or retina, heart and hypertension disorders, kidney disorders.

The main principle of handling diabetes mellitus complications is by blood sugar levels controlling so as not to damage the body organs. Handling provided includes medical treatment, diet management, application of healthy lifestyles for diabetics, the better a person to manage blood sugar levels, actually blood pressure and blood lipid levels are lower the risk of diabetes mellitus complications. Proper eating patterns, adopting healthy lifestyle by diligently exercising, maintaining weight, do not smoke, avoid cigarette smoke and avoid blood pressure and cholesterol increased, all of them will support a person to stay healthy and reduce the risk of diabetes complications.

The signs and symptoms of diabetes are disregarded by many because of the chronic progression of the disease. People do not consider this as a serious problem because unlike many other diseases the consequences of hyperglycaemia are not manifested immediately. People are not aware that damage can start several years before symptoms become noticeable. This is unfortunate because recognition of early symptoms can help to get the disease under control immediately and to prevent vascular complications.

Common symptoms include the following:
Frequent urination, excessive thirst, unexplained weight loss, extreme hunger, sudden vision changes, tingling or numbness in the hands or feet, feeling very tired much of the time, very dry skin, sores that are slow to heal, more infections than usual
Some people may experience only a few symptoms that are listed above. About 50 percent of people with type 2 diabetes don't experience any symptoms and don't know they have the disease.

There are three main types of diabetes:

Type 1 Diabetes: About 5 to 10 percent of those with diabetes have type 1 diabetes. It's an autoimmune disease, meaning the body's own immune system mistakenly attacks and destroys the insulin-producing cells in the pancreas. Patients with type 1 diabetes have very little or no insulin, and must take insulin everyday. Although the condition can appear at any age, typically it's diagnosed in children and young adults, which is why it was previously called juvenile diabetes.

Type 2 Diabetes: Accounting for 90 to 95 percent of those with diabetes, type 2 is the most common form. Usually, it's diagnosed in adults over age 40 and 80 percent of those with type 2 diabetes are overweight. Because of the increase in obesity, type 2 diabetes is being diagnosed at younger ages, including in children. Initially in type 2 diabetes, insulin is produced, but the insulin doesn't function properly, leading to a condition called insulin resistance. Eventually, most people with type 2 diabetes suffer from decreased insulin production.

Gestational Diabetes: Gestational diabetes develops during pregnancy. It occurs more often in African Americans, Native Americans, Latinos and people with a family history of diabetes. Typically, it

disappears after delivery, although the condition is associated with an increased risk of developing diabetes later in life.

Diabetes usually is diagnosed with the following tests that measure the glucose levels in your blood: Fasting Plasma Glucose Test This is the standard test for diagnosing type 1 and type 2 diabetes. You must not eat or drink anything for at least eight hours prior to this simple test in which blood is drawn to check your sugar levels. A diagnosis of diabetes will be made if you have a fasting blood sugar level of 126 milligrams per deciliter or higher on two separate days. Other Tests Diabetes also may be diagnosed based on a random high glucose level of 200mg/dl and symptoms of the disease. Your doctor may wish to perform an oral glucose tolerance test, which is the traditional test for diabetes mellitus.

In addition to the description above, one of the factors that can control and reduce blood sugar levels namely consume tomato juice routinely every day after going through the heating process on tomatoes before it is used as a processed drink or juice.

The benefits of consuming different types of fruit and vegetable are impressive, and tomatoes are no different. As the proportion of plant foods in the diet increases, the risk of developing heart disease, diabetes, and cancer decreases. There are different types and sizes of tomato, and they can be prepared in different ways. These include cherry tomatoes, stewed tomatoes, raw tomatoes, soups, juices, and purees. The health benefits can vary between types. For example, cherry tomatoes have higher beta carotene content than regular tomatoes. High fruit and vegetable intake is also linked to healthy skin and hair, increased energy, and lower weight. Increasing the consumption of fruits and vegetables significantly decreases the risk of obesity and overall mortality.

So far, tomatoes have been processed as a popular sauce for people to eat with fried chicken, french fries and other fried food preparations. Based on the research results, tomato juice can reduce blood sugar levels of patients, from this matter, farmer will also get economic benefits because the selling price of tomatoes may be more improved so that their lives, especially tomato farmers will also be better going forward

Lycopene is an antioxidant that may support prostate health and prevent heart disease and macular degeneration. It is found in many foods such as tomatoes

The goal of diabetes management is to keep blood glucose levels as close to normal as safely possible. Since diabetes may greatly increase risk for heart disease and peripheral artery disease, measures to control blood pressure and cholesterol levels are an essential part of diabetes treatment as well. People with diabetes must take responsibility for their day-to-day care. This includes monitoring blood glucose levels, dietary management, maintaining physical activity, keeping weight and stress under control, monitoring oral medications and, if required, insulin use via injections or pump.

Tomato (*Lycopersicum commune*) is one of the agricultural commodities that have multifunction potentially to be processed as food product. One food ingredient that is associated to blood glucose levels decreased is tomatoes. Tomatoes have main active substance called lycopene. Lycopene is a carotenoid group that is not only important as red pigment, but it is also very beneficial for health, which reduces blood glucose levels by reducing insulin resistance (Astuti & Murwani, 2013). Besides that, tomatoes are food type that is available in home, it has fresh taste, aroma and an affordable price, and has the effect of blood sugar levels reducing, lycopene content in tomatoes is highest with other types of fruits and vegetables, lycopene content in tomatoes can reach 3 times more than other vegetables and fruits. A number of studies have shown that consume foods that rich in lycopene can prevent diabetes. Research conducted by Astuti in Semarang (2008), stated that there was decrease in fasting blood glucose levels after giving tomato juice for 3 weeks. Decreased of fasting blood glucose levels were shown with an average of 9.00 mg / dl (7.64%). In the test there was significant difference between blood glucose in respondents who did not spend tomato juice that was decreased by 4 mg / dl (Astuti, 2013).

Lycopein content in tomatoes that have been through the heating process will be more easily absorbed by the body compared to fresh tomatoes. In the lycopein formation, temperature has an important role, if the temperature rises, the lycopein that is formed will be more. Lycopein in tomatoes will be more easily absorbed by the body if they are processed into juice. The lycopein content in 100 grams of juice tomatoes made as much as 12.8 mg while in 100 grams of fresh tomatoes as much as 5.8 mg. Lycopein can reduce blood glucose by reducing the hormone insulin resistance, so that cell tolerance to glucose increases so that glucose levels excess can be overcome (Astuti & Murwani 2013).

Figure 1: Picture of Fresh Tomatoes

2 METHOD

This research conducted in Lau Rakit Village, STM Hilir Sub-District, Deli Serdang Regency, North Sumatra in 2019. This research type was quasi experiment with research design that used equivalent time sample design, which is an experimental study involving 2 samples which are time-based. The research method is done by giving treatment to the first sample, while the second sample did not need to be given treatment. Then both samples are observed repeatedly, it is aimed to see the changes and effectiveness of the impact of giving tomato juice to respondents' blood sugar levels after giving tomato juice which is done by using purposive sampling technique for 20 respondents in treatment group and 20 respondents in control group with fasting sugar criteria > 126 mg/dl, did not use insulin injection and herbal supplements, pay attention to carbohydrate intake consumed daily and healthy lifestyle such as: not smoking, adequate rest, avoiding stress, exercising.

This research conducted with initial steps of collecting data on blood sugar levels, assessment of carbohydrate intake and duration of diabetes, and dietary consultations throughout the study. Giving tomato juice is done by visiting the patient's homes with type 2 diabetes mellitus. For 2 weeks the treatment group respondents were given tomato juice but they did not consume diabetes medication and set a low-sugar diet and pay attention to a healthy lifestyle such as: not smoking, adequate rest, avoiding stress, exercise. Whereas in the control group respondents still consume drugs and also adjust their diet by consuming foods that are low in sugar and pay attention to healthy lifestyles such as: not smoking, adequate rest, avoiding stress, exercising. The statistical test used by Wilcoxon test, before the Wilcoxon test was performed, then the data normality test was performed and the abnormal data distribution was found so it was determined to test the hypothesis of this study conducted with Wilcoxon test.

Table 1: Concentration of Blood Sugar at Time and Fasting

Blood Glucose Level (mg/dL)	Blood	Not DM	Debatable DM	DM
In the time that (mg/dL)	Plasma Vena	<110 mg/dL	110-199 mg/dl	>200 mg/dL
Fasting (mg/dL)	Plasma Vena	<100 mg/dL	110-125 mg/dL	>126 mg/dL
	Darah Kapiler	<90 mg/dL	90-99 mg/dL	>110 mg/dL

2.1 How to Severe Tomato Juice

The intervention was administer 200 ml of tomato juice from 180 gr of red tomato *Lycopersicum commune* which was boiled with water at temperature of 70-90 ^{0}C for 10 minutes and it was filtered without sugar with frequency of 1 time / day for 2 weeks. Giving tomato juice is done directly by researchers and each subject must drink it in front of the researcher until it runs out. Blood glucose levels are measured with glucose meter. Before conducting the intervention, the researcher examined the respondent's blood sugar level and after the intervention the researcher measured the respondent's sugar level again, this activity was carried out by the researcher for 2 weeks.

The procedures for making tomato juice are as follows: Tomatoes used are fresh red tomatoes, wash tomatoes thoroughly. Then the tomatoes that have been washed and then boiled with water at a temperature of 70-90 ^{0}C for 10 minutes and weighed as much as 180 grams per portion then blended with 20 cc of water, so that 1 portion of 200 cc of tomato juice, tomato juice is made according to the number

of research samples . Rules for giving tomato juice is to give once a day as much as 200 cc in the morning at 09.00 a.m. and drink one hour after eating, after 1 hour of giving tomato juice respondents' blood sugar levels must be measured.

Tomato sauce, tomato paste, ketchup chances are that you eat plenty of cooked tomatoes. But if you don't, now would be a good time to start. If you're limiting yourself to fresh tomatoes, then you're only getting about 4% of the powerful antioxidant lycopene that this veggielike fruit has to offer, according to research published in the *International Journal of Food Sciences and Nutrition*. That's because raw tomatoes have thick cellular walls that make it difficult for our bodies to absorb lycopene. Once they're cooked, however, the lycopene becomes much easier for our bodies to utilize.

Tomatoes have long been known to be a good source of lycopene, the phytochemical which makes them red but which also has significant antioxidant properties. Now new research has shown that this antioxidant power can be boosted even more through the simple act of cooking the tomatoes. Tomato samples were heated to 88 degrees Celsius for two minutes, 15 minutes and 30 minutes. Consistent with previous studies, vitamin C content decreased by 10, 15 and 29 per cent respectively when compared to raw, uncooked tomatoes. However, the research revealed that the beneficial trans-lycopene content of the cooked tomatoes increased by 54, 171 and 164 per cent respectively. Levels of cis -lycopene (which the body easily absorbs) rose by 6, 17 and 35 per cent respectively. Antioxidant levels in the heated tomatoes increased by 28, 34 and 62 percent, respectively.

While the antioxidant activity in tomatoes is enhanced during the cooking process, vitamin C loss occurs when the food's ascorbic acid is oxidised to dehydroascorbic acid and other forms of nutritionally inactive components. Lycopene is the most-efficient single oxygen quencher, and devours more than 10 times more oxygenated free radicals than vitamin E

Lycopene, the pigment that gives tomatoes their colour, is thought to offer protection against certain types of cancer - especially prostate cancer - and heart disease**.** Plus, some small studies show that it may even help to protect the skin from ultraviolet light - though larger studies are needed before recommendations can be made.

Although it is an easy assumption that when it comes to nutritional value, fresh fruit and vegetables always have the edge over cooked or processed, tinned tomatoes prove this isn't always the case

They are actually a better source of lycopene than fresh tomatoes because the canning process helps to break down some of the touch cell walls, releasing the lycopene, which makes it easier for the body to absorb. Like fresh tomatoes, the tinned variety provide useful amounts of beta carotene, vitamin C and just one tinned plum tomato or a quarter of a 400 g tin of chopped tomatoes counts as one of your five a day.

Lycopene is found naturally in the human body and is generally considered safe for consumption through food products. Anyone who is interested in supporting general health and well-being should be consuming fruits and vegetables, like tomatoes. No studies have concretely determined the definitive causal relationship between an increase in lycopene and specific changes in the body, but many studies have shown that diets rich in lycopene seem to improve prostate, cardiovascular, and eye health, and general well-being. Doctors do not usually diagnose 'lycopene deficiency' but if you have benign prostate hyperplasia, exercise induced asthma, macular degeneration, hypertension, or gingivitis, increasing your lycopene intake could prove beneficial. If you are considering a lycopene supplement, you may want to consult your doctor firs

Ingredients of tomato juice: 180 gram tomatoes (size of 1 serving of tomato juice), blenders, pans, filters, measuring cups and scales.

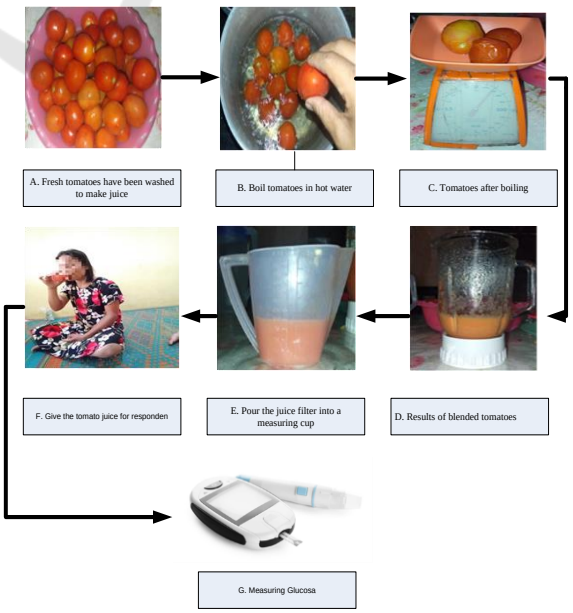

Figure 2: How to make tomatoes juice

3 RESULTS AND DISCUSSION

The study results obtained the characteristics of majority respondents aged 51-61 years old with male sex, agricultural work and based on the duration of suffering from diabetes mellitus the majority of 1-2 years. It is found that each respondent in the treatment group experienced blood sugar levels decreased but they did not consume diabetes medication and set low sugar diet after they given as much as 200 ml of tomato juice for 14 days routinelyor 2 weeks. Blood sugar levels decreased occur because of the lycopein content in tomato juice. Lycopein can reduce blood glucose by reducing insulin hormone resistance, so that cell tolerance to glucose increases so that glucose levels excess can be overcome. The lycopein content will be more if it is through the heating process and processed into juice, it will be more easily absorbed by the body. In the lycopein formation, temperature has an important role, if the temperature rises, the lycopein formed will be more. The lycopein content in 100 grams of tomatoes juice as much as 12.8 mg while in 100 grams of fresh tomatoes as much as 5.8 mg. While in the control group did not consume tomato juice but still consume drugs and also regulate eating patterns by consuming foods that are low in sugar and pay attention to a healthy lifestyle such as: not smoking, getting enough rest, avoiding stress, exercising. Based on research that has been done, the results show that there is a decrease in glucose levels of patients with diabetes mellitus after consuming tomato juice for 2 weeks.

While the antioxidant activity in tomatoes is enhanced during the cooking process, vitamin C loss occurs when the food's ascorbic acid is oxidised to dehydroascorbic acid and other forms of nutritionally inactive components. Lycopene is the most-efficient single oxygen quencher, and devours more than 10 times more oxygenated free radicals than vitamin E

Then the Wilcoxon statistical test results of treatment group obtained p value = 0,002 < α = 0.05, which means that there is significant influence between the administration of tomato juice to blood sugar levels decreased in patients with diabetes mellitus treatment group. The difference in blood sugar levels before and after tomato juice given can be seen in the following table:

Table 2: Blood Sugar Levels Pre and Post Giving Tomato Juice in the Treatment Group

Blood Sugar Level		Frequency (N)		Percentage (%)	
Pre	Post	Pre	Post	Pre	Post
245	208	2	1	10	5
246	209	1	1	5	5
250	210	1	1	5	5
256	212	1	1	5	5
258	213	1	2	5	10
265	220	1	1	5	5
270	230	1	1	5	5
271	234	1	1	5	5
275	235	1	1	5	5
279	239	1	1	5	5
280	243	1	2	5	10
285	246	2	1	10	5
289	247	2	1	10	5
290	255	4	3	20	15
0	256	0	1	0	5
0	258	0	1	0	5
Total		20	20	100	100

Table 3: Blood Sugar Levels Pre and Post Giving Tomato Juice in the Control Group

Blood Sugar Level		Frequency (N)		Percentage (%)	
Pre	Post	Pre	Post	Pre	Post
245	225	1	1	5	5
247	235	1	1	5	5
259	239	2	1	10	5
276	247	1	1	5	5
265	250	2	1	10	5
267	253	1	1	5	5
300	257	1	1	5	5
271	258	1	1	5	5
280	260	2	1	10	5
281	269	1	2	5	10
289	270	1	1	5	5
291	275	1	2	5	10
285	276	3	1	15	5

290	280	1	2	5	10
305	281	1	1	5	5
0	291	0	1	0	5
0	292	0	1	0	5
Total		20	20	100	100

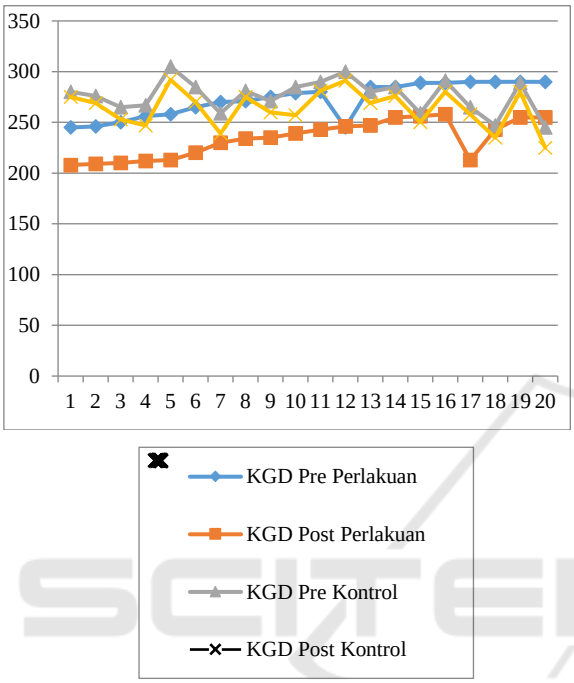

Figure 3: Blood Sugar Levels Pre and Post Giving of Tomato Juice in the Treatment and Control Group

Based on Figure 2 above, it can be seen the average results of blood sugar levels before being given tomato juice in the treatment group 272.4 mg / dl with a minimum value of 245 mg / dl and a maximum of 290 mg / dl, a median of 277 mg / dl with a standard deviation of 16,944. While the average results of blood sugar levels after being given tomato juice in the treatment group 234.05 mg / dl with a minimum value of 208 mg / dl and a maximum of 258 mg / dl, median 237 mg / dl with a standard deviation of 18.266.

Based on statistical tests, the respondents' blood sugar levels of the control and treatment group can be known the p value = 0.002 ($p < \alpha = 0.05$), which means that there were significant differences between the treatment group that consumed tomato juice with control group that did not consume tomato juice. The results of the average blood sugar levels in the control group were 242.70 mg / dl, with a standard deviation of 15,076, with a minimum value of 220 mg / dl and a maximum of 265 mg / dl.

While the average results of blood sugar levels before and after administration of tomato juice for treatment group 234.05 mg / dl, with a standard deviation of 18,266, with a minimum value of 208 mg / dl and a maximum of 258 mg / dl.

4 CONCLUSION

Based on research that has been done, it can be concluded that the administration of tomato juice in treatment group is effective in reducing blood glucose levels of Diabetes Mellitus patients without taking diabetes medications and regulating low glucose diet.

5 SUGGESTION

The study results can provide input for nurses in providing services to diabetes mellitus patients in the community that the use of tomato juice is one of the efforts in reducing blood sugar levels without consuming pharmacological therapy.

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