THE EFFECT OF GIVING RED DRAGON FRUIT JUICE AND EDUCATION ON REDUCING BLOOD SUGAR LEVELS OF PATIENTS WITH TYPE 2 DIABETES MELLITUS IN THE WORK AREA OF BULILI HEALTH CENTRE, PALU CITY, INDONESIA

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KEYWORDS

Type 2 diabetes mellitus, juice, red dragon fruit, education

ABSTRACT:

Background. Type 2 diabetes mellitus is a chronic metabolic disease characterised by elevated blood sugar levels. Treatment of diabetic patients can be done with pharmacological and non-pharmacological treatments. Red dragon fruit is known to have pharmacological effects as an antidiabetic.

Objective. This study aims to determine the effect of giving red dragon fruit juice and education on blood sugar levels in patients with type 2 diabetes mellitus.

Methods. This study used quasi experimental method with the non randomised pre-test post-test control group design. The research location was in the working area of Bulili Health Centre, Palu City. Sampling using purposive sampling technique, with a total sample of 52 respondents, 26 intervention groups and 26 control groups. Data analysis using STATA application with Wilcoxon test and Independent t-test.

Results. This study shows that there is a difference in blood sugar levels in patients with diabetes mellitus before and after giving red dragon fruit juice and education in the intervention group (p = 0,000) and there is a difference in blood sugar levels in patients with type 2 diabetes mellitus before and after giving education in the control group (p = 0,000). The average decrease in blood sugar levels in the intervention group of 94.19 mg / dL and the control group of 62.88 mg / dL, with a p-value of 0,025, p < 0,05

Conclusion. There is an effect of giving red dragon fruit juice and education on blood sugar levels of patients with type 2 diabetes mellitus in the working area of Bulili Health Centre, Palu City.

1. Introduction

Diabetes Mellitus (DM) is a chronic metabolic disease characterised by deficient insulin production resulting in abnormalities in insulin secretion leading to elevated blood sugar levels or hyperglycaemia. Insulin is a hormone produced in the pancreas that helps transport glucose (blood sugar) from the

bloodstream into cells so that they can break it down and use it as energy. DM can be said to be a condition where the body does not properly process food to be used as energy. The pancreas is an organ located near the stomach and has an important role in regulating blood sugar levels. It produces the hormone insulin, which aids the uptake of glucose into the body's cells to control blood sugar. [1].

Type 2 Diabetes Mellitus is one of the most common metabolic disorders worldwide and its development is mainly due to a combination of two main factors: impaired insulin secretion by pancreatic β-cells and the inability of insulin-sensitive tissues to respond to insulin. According to the World Health Organisation (WHO), Diabetes Mellitus is a chronic metabolic disease characterised by elevated blood glucose levels, which over time causes damage to the heart, blood vessels, eyes, kidneys and nerves. More than 90% of Diabetes Mellitus cases are T2DM, a condition characterised by deficient insulin secretion by pancreatic β-cells, tissue insulin resistance and an inadequate compensatory insulin secretory response. The progression of the disease makes insulin secretion unable to maintain glucose homeostatis, leading to hyperglycaemia. [2].

The International Diabetes Federation (IDF) organisation found that at least 537 million people aged 20-79 years in the world have diabetes in 2021, equivalent to a prevalence rate of 10.5 of the total population of the same age. Based on gender, the prevalence of diabetes in 2021 is 10.2% in women and 10.8% in men. Countries in the Middle East-North Africa and North America-Caribbean regions ranked first and second with the highest prevalence of diabetes in the 20-79 year old population out of 7 regions in the world at 18.1% and 11.9%. The Southeast Asia region, where Indonesia is located, ranks third with a prevalence of 10%. (IDF, 2021).

Based on data from the Indonesian Health Survey 2023, the prevalence of Diabetes Mellitus in Indonesia in the population aged ≥ 15 years is 2.2%, where provinces that have a prevalence higher or equal to the national average are DKI Jakarta at 3.9%, DI Jakarta 3.6%, East Kalimantan 3.1%, Bangka Belitung 2.8%, North Sulawesi and East Java 2.7%, Banten 2.5%, Central Java and Gorontalo 2.3%, Aceh, West Java and Central Sulawesi 2.2%. Central Sulawesi still found a high prevalence of diabetes cases [3]. Basic Health Research (Riskesdas) conducted in 2018 showed that the prevalence of diabetes in Indonesia based on doctor's diagnosis at the age of >15 years was 2%, this number increased compared to Riskesdas 2013 which was 1.5% and continued to increase in 2023 by 2.2%. Almost all provinces in Indonesia showed an increase in the prevalence of Diabetes Mellitus, with the highest percentage in the DKI Jakarta area, which is around 3.4%. Central Sulawesi Province found cases with a total of 11,548 cases (1.5%) and occupied the 11th position. [4].

Based on data from the Central Sulawesi Provincial Health Office, the prevalence of cases of diabetes mellitus based on city districts in 2022 was the highest, namely Palu City at 62.79%, Buol at 62.42%, Tolitoli at 58.97%, North Morowali 55,18%, Banggai Islands 51.82%, Morowali as much as 43.71%, Tojo Una-Una as much as 29.46%, Poso as much as 22.47%, Banggai Laut as much as 15.23% Sigi as much as 14.77%, Banggai as much as 12.28%, Donggala 6.51% and Parigi Moutong as much as 3.85%. [5].

The Health Office of Palu City is an implementing element of regional autonomy in the health sector which is under and responsible to the Mayor of Palu. Based on preliminary studies conducted at the Health Office of Palu City, morbidity data obtained through health service facilities obtained through the recording and reporting system of 10 outpatient diseases at health centres and hospitals. For the 5 highest DM diseases in existing health centres in Palu City in 2023, namely bulili health centre

(1.31%), lere health centre (1.26%), tipo health centre (1.14), singgani health centre (1.12%), talise health centre (1.07%), kawatuna health centre and birobuli health centre (1.05%). [6].

Diabetes Mellitus management efforts are with pharmacological and non-pharmacological therapies. Pharmacological therapy is treatment using oral medication or injections. While non-pharmacological therapy is treatment using herbal ingredients that have less effect than synthetic drugs. Some plants have been researched and have the potential as anti Diabetes Mellitus, red dragon fruit because this fruit is a fruit that can be consumed to reduce blood glucose levels in people with Diabetes Mellitus. [7].

Based on data from Riskesdas (2018), of the total proportion of people with Diabetes Mellitus who do not routinely take medicine, 50.40% of them feel they are healthy, 30.24% do not routinely go to health facilities, 25.29% take traditional medicine, 18.77 often forget to take medicine, 18.20 fall into other reasons, 12.58 cannot stand the side effects of drugs, 8.45% cannot afford to buy medicine and 2.11 drugs are not available at health service facilities. Meanwhile, from the SKI data (2023), of the total proportion of people with Diabetes Mellitus who do not routinely take medicine, 44.7% feel healthy, 21.2% drink OT, 19.0% are bored/lazy/forget to take medicine, 7.2% cannot stand ESO, 5.7% fall into other reasons, and 2.1% of drugs are not available. Patient non-adherence to Diabetes Mellitus treatment can be one of the causes in the failure of Diabetes Mellitus therapy which can result in blood sugar remaining high or uncontrolled and an increased risk of other cardiovascular disease complications.

One of the efforts that can be done is with alternatives that are more easily accessible to people with Diabetes Mellitus, namely with red dragon fruit juice. Non-pharmacological treatment can be done by giving traditional medicine from plants that can be utilised and can reduce blood sugar levels including red dragon fruit. Red dragon fruit is also a useful food ingredient in lowering blood sugar levels. This is in accordance with research Pramesti & Sukesi (2020) Increased blood glucose levels can be controlled with chemical drugs, besides that food regulation also has an effective effect on lowering blood glucose levels which is relatively cheap. Red dragon fruit (Hylocereus Polyrhizus) is one of the best fruits in the functional food category. according to the Malaysian Faculty of Medicine division said that giving red dragon fruit 200 - 300 g / day can reduce blood sugar and choleterol levels in patients with type 2 DM. This intervention was carried out for 14 days, after giving the intervention for 14 days the results showed that red dragon fruit juice can reduce blood sugar. [9].

Red dragon fruit, also known as dragon fruit, comes from a cactus plant that belongs to the genus Hylocereus, family Cactaceae, order Cactaes, and class Dicotyledonae. The origin of this fruit is in Mexico, Central America, and South America, but currently, dragon fruit cultivation is also carried out in several countries in the Asian region, including Indonesia. The shape of the fruit is elongated round and has a rather thick skin. [10].

Red dragon fruit is believed to have the effect of lowering blood sugar levels because it contains antioxidant compounds in the form of flavonoids. Flavonoids are known to reduce blood glucose levels by protecting β cells as insulin producers from damage and restoring insulin receptor sensitivity in cells and increasing insulin sensitivity. [11]. High insulin sensitivity allows the body's cells to use blood glucose more effectively and reduce blood sugar. . Lycopene contained in dragon fruit is also not only a red colour giver, lycopene can also affect insulin hormone resistance so that the body's tolerance to glucose is increased [12].

This water-soluble fibre increases gastric viscosity and thus decreases the rate of glucose absorption. Consumption of adequate amounts of fibre can have metabolic benefits on blood glucose control. Water soluble fibre increases food transit time in the intestine, delays gastric emptying and slows glucose absorption. If glucose absorption is slow, insulin secretion will not be excessive, which will reduce insulin demand and increase insulin sensitivity. The fibre found in red dragon can bind a lot of water and form a gel, so the possibility of glucose to come into contact with the small intestinal wall and enter the blood becomes smaller. When the level of glucose entering the blood is less, then the insulin produced by the pancreas also becomes less, so that blood glucose levels decrease. [13]..

Non-pharmacological therapy of red dragon fruit juice is believed to have an effect on lowering blood sugar. Seeing this, red dragon fruit juice can be used as an option to reduce blood glucose levels, especially in people with Type 2 Diabetes Mellitus, considering that this fruit is widely circulated in the market and has become a local commodity, especially red dragon fruit. [14].

Another study also explained the intervention group of red dragon fruit juice, with the administration of 250 ml of juice every day for 14 days, where the administration was carried out in the morning, obtained pre results of 228.50 mg/dl and the last post results of 173.84 mg/dl, with statistical test results obtained p value = 0.001 ($p < 0.05$), which means there is a difference in non-fasting blood glucose levels when between pre and post-test. The results of statistical tests with the Mann-Whitney test to test the difference in the effect of dragon fruit juice on lowering blood sugar levels in Diabetes Mellitus obtained a value of $P = 0.044$ because of the value of $p < 0.05$. This means that there is a significant difference between the pre and post-test. This means that there is a significant difference between the dragon fruit groups with an average of 30.73 mg/dl and 22.27 mg/dl, respectively. [15].

Blood sugar control is the key to successful treatment of patients with DM. DM is a chronic disease that occurs when the pancreas is unable to produce insulin (a hormone that plays a role in blood sugar regulation) so that people with DM will experience increased blood sugar levels. Poorly controlled blood sugar tends to cause various complications, disability and death. Education is one of the four pillars of DM management. The purpose of management in the form of education is to increase DM patients' knowledge about the disease and correct medication management. In addition, educational activities can also increase the promotion of healthy living in the community. [16]..

In the management of DM, among others, through education with an emphasis on promotive and preventive. This intervention can establish people with DM in self-care by controlling blood sugar levels. Health education can improve a person's ability to improve cognition, skills, and attitudes in carrying out self-care for people with DM. During and after the health education process, there was a process of behavioural adoption from respondents related to the theme of the education provided, namely non-pharmacological management of dragon fruit juice so that Type 2 Diabetes Mellitus patients can control their blood sugar to prevent complications [17]. [17].

Based on the results of blood sugar measurements, it is known that the average blood sugar before education is 244.19 with a standard deviation (SD) of 51.34. The average value of blood sugar decreased after the diabetes education intervention was 166.06 with a standard deviation of 35.63. The paired t-test results of the blood sugar examination before and after the provision of diabetes education. The data showed that there was an effect between the provision of diabetes education on reducing blood glucose in patients with Type 2 DM with a significance value of $p = 0.000$ and an average value of 78.13 with a standard deviation of 41.91. [16].

At this time, many traditional treatments are used that aim to treat and prevent diseases, one of which is the use of red dragon fruit (Hylocereus polyrhizus). Therefore, red dragon fruit can be used as a therapy to lower blood glucose levels. Red dragon fruit is easily found in various regions and tastes sweet so it is favoured by the community, red dragon fruit also has an effect in lowering blood glucose levels.

Based on the above background, researchers are interested in conducting research on the effect of giving red dragon fruit juice and education on reducing blood sugar levels during Diabetes Mellitus Type 2 patients in the Bulili Health Centre Working Area, Palu City.

2. Methods

This study uses quantitative research methods with experiment, in this case quasi experimental with pretest-postest with test control group design. Matching was also done to minimise bias by ensuring the similarity of the sample in terms of gender. The dependent variable was blood sugar level. The independent variables were dragon fruit juice administration and education. This study was conducted at Bulili Health Centre, Palu City, 2024.

Population and Sample

The total population was 953 people. The sample size calculation was carried out using the Federer formula. A total of 52 respondents who met the inclusion and exclusion criteria were divided into 26 treatment groups and 26 control groups. The intervention group was given red dragon fruit juice and education while the control group was given education. Participants of the Chronic Disease Management Program (PROLANIS) of Puskesmas Marusu Maros Regency who had diabetes mellitus were included in the intervention group. Sample selection was done by purposive sampling.

Intervention

Patients' blood sugar levels were measured 1-2 ja after meals on day 0 (before intervention), days 3, 7, 10 and 14 for follow-up of blood sugar levels of patients with Type 2 Diabetes Mellitus. The intervention group was given dragon fruit juice and education as well as education; the control group only received education. Patients with Type 2 diabetes mellitus were asked to answer a questionnaire. The intervention group received 250ml red dragon fruit juice daily and drank it in the morning. The trial protocol was as follows:

Respondents from the intervention and control groups completed a demographic questionnaire to determine their characteristics.

On days 0 and 14 of the study, baseline blood sugar levels were measured before the intervention. Dragon fruit juice was consumed according to the dose. Blood sugar levels were measured by taking a blood sample from the respondent's fingertip using an Easy Touch General Check Up (GCU) brand glucometer and recording it on a blood sugar control sheet.

Ethical Considerations

This study is a research that has obtained permission from the Research Ethics Commission of the Faculty of Public Health, Hasanuddin University with number 1794/UN4.14.1/TP.01.02/2024. All respondents in both the intervention and control groups were given information about the purpose of the intervention and the procedures to be carried out, and the names and privacy of respondents were kept confidential. Both groups were also asked to sign a consent form before the study.

Data Analysis

Data were processed using STATA version 14. This study used two analyses: univariate and bivariate. Data were tested with univariate analysis. Bivariate analysis was used to assess differences in blood sugar levels of patients with Type 2 Diabetes Mellitus between the intervention group and the control group, using the Wilcoxon test to analyse significant differences. A value of $p < 0.05$ was considered statistically significant.

Methods

Characteristics of the Research Sample

Table 1 shows that the respondents were mostly female, with the same proportion between the intervention and control groups. Respondents in this study were mostly in the Pre-elderly age group in the intervention group (53.85%) and control group (61.54%). The majority of respondents had a high school education in the intervention group (46.15%) and control group (53.85%). Most respondents worked as housewives in the intervention group (38.46%) and control group (34.62%). Respondents were mostly married in the intervention group (65.38%) and control group (65.38%).

Table 1. Socio-demographic Characteristics of the Sample.

Variables	Intervention	Control
Gender		
Male	8 (30,77%)	8 (30,77%)
Women	18 (69,23%)	18 (69,23%)
Age Group		
Adults	10 (38,46%)	12 (46,25%)
Pre-elderly	16 (62,54%)	14 (53,85%)
Education		
SD	2 (7,69%)	1 (3,85%)
SECONDARY SCHOOL	6 (23,08%)	3 (11,54%)
HIGH SCHOOL	12 (46,15%)	14 (53,85%)
D3 / S1 / S2 / S3	6(23,08%)	8 (30,77&)
Jobs		
Not Working	5 (19,23%)	5 (19,23%)
IRT	10 (38,46%)	8 (30,77%)
Private Employee	2 (7,69%)	6 (23,08%)
Self-employed	7 (26,92%)	7 (26,92%)
Farmers	2 (7,69%)	0 (0,0%)
Marital Status		
Married	17 (65,38%)	17 (65,38%)
Death Divorce	0 (0,0%)	1 (3,85%)
Unmarried	9 (34,62%)	8 (30,77%)

Table 2 shows that there were more female respondents with the same proportion between the intervention and control groups, 17 respondents each (69.23%).

The age group of respondents in this study was mostly in the pre-elderly age group, namely 16 respondents (61.54%) in the intervention group and 14 respondents (53.85%) in the control group.

Education level characteristics, the majority of respondents had a high school education in both groups as many as 14 respondents (53.85%) in the control group and in the intervention group as many as 12 respondents (46.12%).

The type of work of the majority of respondents in this study was as housewives. The majority of respondents with the type of work of housewives were 10 respondents (38.46%) in the Intervention group and 8 respondents (30.77%) in the control group.

Marital status in this study the majority of respondents had married status. Where the intervention group and control group have the same proportion of married status groups, namely 17 respondents (65.38%).

able 2. Clinical characteristics of the sample

Variables	Intervention	Control
Body Mass Index (BMI)		
Normal	9 (34,62%)	13 (50,00%)
Overweight	6 (23,08%)	3 (11,54%)
Obesity	11 (42,31%)	10 (38,46%)
Smoking Behaviour		
Yes	9 (34,62%)	8 (30,77%)
No	17 (65,38%)	18 (69,23%)
Family History		
Yes	12 (46,15%)	16 (61,54%)
No	14 (53,85%)	10 (38,46%)
Duration of Suffering		
1-6 months	13 (50,00%)	13 (50,00%)
6-12 months	13 (50,00%)	13 (50,00%)
Diet		
Good	18 (69,23%)	9 (34,62%)
Bad	8 (30,77%)	17 (65,38%)
Physical Activity		
Yes	18 (69,23%)	11 (42,31%)
No	8 (30,77%)	15 (57,69%)
Herbal Alternatives		
Yes	8 (30,77%)	16 (61,54%)
No	18 (68,23%)	10 (38,46%)

Blood Sugar Levels in Intervention and Control Groups

Table 3 shows that the mean value of blood sugar levels in the intervention group decreased before and after consumption of dragon fruit juice and providing education, namely the difference of 94.19 mg/dL with a p value of 0.000 <0.05, which means that there is a significant difference in blood sugar levels before and after consuming red dragon fruit juice consumption and providing education in the intervention group. The mean value of blood sugar levels in the control group also decreased, namely the difference of 62.88 mg/dL with a p value of 0.000 <0.05, which means there is a significant difference in blood sugar levels before and after providing education in the control group.

Table 3. Differences in Blood Sugar Levels in the Intervention Group and Control Group

Variables	Blood Sugar Levels		
	Pre-Test	Post-Test	p-Value
Intervention Group			
n	26	26	
Mean	286,08	191,88	0,000
SD	76,95	33,03	
Control Group			
n	26	26	
Mean	305,46	242,58	0,000
SD	66,09	40,31	

Source: Intervention: Wilcoxon test, Control: Independent t-test

Table 4 shows that the average blood sugar level at *pre-test* was higher in the control group, 305.46 mg/dL, than in the intervention group, 286.08 mg/dL. The statistical test results at the time of the *pre-test* obtained a p value of 0.335> 0.05, meaning that there was no significant difference in blood sugar levels at the time of the *pre-test* in the intervention group or control group. The average blood sugar level at the time of the *post test* was also higher in the control group which was 242.58 mg/dL compared to the intervention group which was 191.88 mg/dL, meaning that the intervention group had a smaller average blood sugar level when compared to the control group after the *post test*. The statistical test results on the *post* test obtained a p value of 0.000 <0.05 which means there is a significant difference in blood sugar levels at *post test* in the intervention group and control group.

Table 4. Difference in Pre-Post Blood Sugar Level between Intervention Group and Control Group

Variables	Blood Sugar Levels		
	Intervention	Control	p-Value
Pre-test			
n	26	26	
Mean	286,08	305,46	0,347
SD	76,95	66,09	
Post-Test			
n	26	26	
Mean	192,88	242,58	0,000
SD	33,03	40,31	

Source: Pretest: Independent t-test, Posttest: Mann-Whitney Test

Based on table 5, it shows that the average value of the difference in blood sugar levels in the intervention group is 94.19 mg/dL and the control group is 62.88 mg/dL and the statistical test results between the intervention and control groups obtained a p value of 0.025 <0.05, meaning that there is a significant difference between the intervention group and the control group.

Table 5. Analysis of Mean and Difference of Blood Sugar Levels in Intervention and Control Groups at Bulili Health Centre

Blood Sugar Levels	Group	Mean	SD	p-Value
Pre-Post Test (n=52)	Intervention	94,19	55,22	0,025
	Control	62,88	41,67	

Source: Independent t-test

DISCUSSION

Difference in Blood Sugar Levels Before and After Intervention in Intervention and Control Groups

The results of this study indicate that blood sugar levels of the intervention group decreased before and after the administration of red dragon fruit juice and education in patients with Type 2 Diabetes Mellitus by 94.19 mg/dL and blood sugar levels of the control group also decreased before and after the provision of education in patients with Type 2 Diabetes Mellitus by 62.88 mg/dL. Giving red dragon fruit juice at a dose of 200grams in 250 ml for 14 days proved to have an effect in reducing blood sugar in patients with Type 2 Diabetes Mellitus. The content contained in dragon fruit with a dose of 200grams which has an effect in reducing blood sugar levels in patients with Type 2 Diabetes Mellitus is Vitamin C 18mg, Flavonoids 14.42mg / CE, fibre 0.18g and Lycopene 6.8mg, consumed once a day every morning regularly. [18].

Monitoring of dragon fruit juice drinking was conducted in this study. Where the researcher collaborates with the family of patients with Type 2 Diabetes Mellitus in terms of drinking red dragon fruit juice regularly and is spent every morning in a day. At the time of the study, researchers gave dragon fruit juice to respondents every day so that the red dragon fruit juice consumed *was fresh,* then researchers also directly monitored the consumption of dragon fruit juice every day to respondents. By directly monitoring the consumption of red dragon fruit juice every day, researchers can obtain more accurate data on the effect of the juice on blood sugar management in patients with type 2 diabetes.

This is in line with previous research on red dragon fruit juice, with the administration of 250 ml of juice every day for 14 days, where the administration is carried out in the morning, obtained *pre-test* results of 228.5 mg/dl and the last *post-test* results of 173.84 mg/dl, with the results of statistical tests obtained p value = 0.001 ($p < 0.05$), which means there is a difference in non-fasting blood glucose levels when between *pre* and *post-test*. The results of statistical tests with the Mann-Whitney test to test the difference in the effect of dragon fruit juice on lowering blood sugar levels in Diabetes Mellitus obtained a value of $P = 0.044$ because of the value of $p < 0.05$. This means that there is a significant difference between the pre and post-test. This means that there is a significant difference between the dragon fruit groups with an average of 30.73 mg/dl and 22.27 mg/dl, respectively. [15].

There was a significant decrease due to one of the factors is the length of suffering in people with Type 2 Diabetes Mellitus, so that people with Diabetes Mellitus less than one year still have a positive attitude in themselves to control their blood sugar levels, so at the time of the intervention they received dragon fruit juice and education on people with Type 2 Diabetes Mellitus to control their blood sugar levels. In addition, in the study conducted for 14 days, Type 2 Diabetes Mellitus patients continued to take OAD regularly to control blood sugar levels and were also diligent in checking blood sugar levels at the health centre every month.

The intervention was carried out for 14 days regularly which affected the decrease in blood sugar levels in patients with Type 2 Diabetes Mellitus at the time of *post-test* measurement of blood sugar levels. This is in line with research (Dewi et al., 2023) that interventions carried out for 14 days regularly such as physical activity, dietary changes and educational support have shown a significant effect on reducing blood sugar levels in patients with Type 2 Diabetes Mellitus. Measuring blood sugar before and after consumption of red dragon fruit juice every morning of the day. This helps to see if there is a significant change in blood sugar levels. Drinking rich red dragon fruit juice in the morning can help

slow the absorption of sugar into the blood, keep blood sugar stable after waking up, and reduce the usual blood sugar spike after breakfast.

Dragon fruit is believed to have the effect of lowering blood glucose levels because dragon fruit contains antioxidant compounds in the form of flavonoids that are protective against damage to beta cells as insulin producers and can increase insulin sensitivity. The way flavonoids work is by inhibiting glucose absorption in GLUT 2 and causing major glucose transporters in the intestine to decrease, causing blood glucose levels to drop and can prevent diabetes mellitus. Dragon fruit is also high in fibre and contains lycopene, a red pigment. Lycopene can affect insulin hormone resistance so that the body's tolerance to glucose increases. The fibre contained in dragon fruit can bind water so that glucose is less likely to come into contact with the intestinal wall and enter the blood. Then the pancreas will produce less insulin because the glucose levels that enter the blood are small so that there is a decrease in blood glucose levels. [26].

In addition, the intervention was carried out for 14 days on a regular basis which affected the decrease in blood sugar levels in patients with Type 2 Diabetes Mellitus at the time of *post-test* measurement of blood sugar levels. Interventions carried out for 14 days regularly such as physical activity, dietary changes and educational support have shown significant effects on reducing blood sugar levels in patients with Type 2 Diabetes Mellitus. [20].

Patients with Type 2 Diabetes Mellitus with less than one year of suffering really need information related to treatment so that blood sugar levels are maintained. In addition, enthusiasm to try non-pharmacological treatments that can reduce blood sugar levels of patients with Type 2 Diabetes Mellitus needs to be a practical and effective alternative treatment. The exploration of non-pharmacological treatments, especially herbal juices, as an alternative for managing Type 2 Diabetes Mellitus (T2DM) has gained traction due to their perceived safety and potential efficacy in improving glycaemic control, evidenced by reduced HbA1c and blood glucose levels. [21].

Proper education and information can improve patient adherence to a comprehensive treatment programme, thereby controlling blood glucose levels. Proper education and information significantly improves patient adherence to a comprehensive treatment programme for diabetes, leading to improved glycaemic control. Studies show that adherence increased to 91.4% after a structured education programme was provided. [22]. In addition, patient-directed and continuous information-giving-based care has been associated with better self-management and adherence, resulting in lower blood glucose levels and improved disease control. [23].

The process of the course of the disease suffered by respondents affects their quality of life where with the disease that has been suffered from year after year causes respondents to feel restless and desperate in treating the disease, especially for respondents who experience complications, it can have an impact that negatively affects their quality of life. Research shows that individuals with diabetes often experience physical and psychological challenges, which can interfere with daily activities and overall well-being. [24]. Complications arising from diabetes significantly reduce the quality of life for affected individuals. Research shows that chronic complications lead to severe physical limitations and increased pain, which adversely affect daily activities and overall health satisfaction. [25].

The decrease in blood glucose levels is because red dragon fruit has components that can provide hypoglycaemic effects that function to balance blood glucose levels such as fibre and antioxidants,

antioxidants can bind free radicals so as to reduce insulin resistance. The types of antioxidants that play the most role in reducing blood glucose levels are flavonoids and betasianin. The flavonoid content in red dragon fruit flesh is 7.21 ± 0.02 mg CE/100 grams. The ability of flavonoids, especially quercetin, is by inhibiting Glucose Transporters 2 (GLUT 2) of the intestinal mucosa so that it can reduce glucose absorption. This causes a reduction in the absorption of glucose and fructose from the intestine so that blood glucose levels drop. [32].

This study also looked at whether there was an effect of providing education to the control group. The results showed a significant difference between the two groups after the provision of education. The educational materials provided are the definition of diabetes mellitus, causes of diabetes mellitus, signs and symptoms of diabetes mellitus, risk factors for diabetes mellitus, the dangers of dm, handling diabetes mellitus both pharmacologically and non-pharmacologically such as non-pharmacological dragon fruit juice and the steps for making it. This education process is carried out according to the predetermined SOP after which a *posttest* is carried out by measuring blood sugar levels. This is in line with previous research where the results of this community service activity showed an increase in the knowledge of health cadres about diabetes mellitus with a mean value difference of 3.25. Health education so that it can be a guide for cadres in educating the community. In the early detection activity of checking random blood sugar levels, it was also found that there were 18 people who had random blood sugar levels > normal. [33].

Diabetes management is divided into two, pharmacological and non-pharmacological. Pharmacological management is by consuming OHO and Insulin. While in non-pharmacological management, education, physical exercise and medical nutrition therapy (consumption of lots of fibre and antioxidants) are carried out. [12].

In the research conducted in addition to giving dragon fruit juice regularly for 14 days, health education was also provided using leaflet media in the intervention carried out. The education contained health education with the title "Non-pharmacological therapy of red dragon fruit juice". The leaflet contains a brief explanation of diabetes, the normal value of blood sugar levels, risk factors for diabetes, the main symptoms of diabetes, the dangers of diabetes and the treatment of diabetes mellitus referring to the ministry of health's educational media. Educational interventions are carried out according to the SOP that has been determined door to door by researchers. The purpose of this education is to ensure that more personalised and direct information can be received by individuals, especially for people with type 2 diabetes who may need more attention in terms of managing their health.

Providing education to patients with Type 2 Diabetes Mellitus was carried out 3 times during the study, namely during the initial observation, day 7 and final observation. At the initial observation, a pre-test was carried out, namely checking the patient's blood sugar while the patient then after giving education at the final observation, the patient's blood sugar was checked again to see a decrease in the patient's blood sugar level after giving education. During the provision of education, Type 2 Diabetes Mellitus patients were also regular in taking OAD so that when the post test was carried out at the final observation, there was a significant decrease in blood sugar levels. This shows that with proper education, patients can make significant changes in managing their blood sugar by monitoring blood sugar regularly and also maintaining proper diabetes mellitus management which contributes to a better reduction in blood sugar levels.

Education is an ongoing process whose progress must be continuously observed. The aim of health education is first of all to increase knowledge about DM. Increased knowledge can be seen by changes in lifestyle and attitudes that ultimately shape behavioural changes in the community and the quality of life of DM patients. [34].

Differences in *Pre* and *Post Test* Blood Sugar Levels between Intervention and Control Groups

Based on the results showed that the average blood sugar level at *pre-test* was higher in the control group which was 305.46 mg/dL than in the intervention group which was 286.08 mg/dL. The statistical test results at the time of the *pre-test* obtained a p value of 0.335> 0.05, meaning that there was no significant difference in blood sugar levels at the time of the *pre-test* in the intervention group or control group. The average blood sugar level at the time of the *post test* was also higher in the control group which was 242.58 mg/dL compared to the intervention group which was 191.88 mg/dL, meaning that the intervention group had a smaller average blood sugar level when compared to the control group after the *post test*. The statistical test results on the *post test* obtained a p value of 0.000 <0.05 which means there is a significant difference in blood sugar levels at *post test* in the intervention group and control group. This shows that the difference in blood sugar levels at *post test* time shows a decrease in blood sugar levels in the intervention group because the intervention group consumed dragon fruit juice and received education compared to the control group who only received education.

Consumption of dragon fruit juice coupled with education provides a better reduction in blood sugar levels compared to only providing education. Red dragon fruit has the potential to prevent diabetes. This can be seen from the trend of decreasing blood glucose levels in subjects given red dragon fruit. Bioactive components contained in red dragon fruit play a role in lowering blood sugar. Dragon fruit contains many antioxidants including flavonoids, brick carotene, lycopene, fibre and vitamin C. Dragon fruit is known to have a variety of health benefits, including lowering cholesterol levels, maintaining blood sugar balance, preventing colon cancer, strengthening kidney and bone function, improving brain function, increasing visual acuity, and acting as a natural colourant. [32].

The successful management of DM is to analyse the relationship between knowledge, exercise, diet and medication adherence with the successful management of type 2 diabetes mellitus. If the management is good, the quality of life can be improved. Good absorption of education, appropriate eating arrangements, regular exercise, and adherence to medication have an impact on stabilising blood glucose and improving quality of life. [35].

According to the observations of researchers and previous studies, it can be concluded that the difference in blood sugar levels at the time of the post test showed a lower average value in the intervention group than the control group because in the intervention group the researchers provided therapy in the form of dragon fruit juice, while in the control group the researchers did not provide dragon fruit juice. So that in patients with diabetes mellitus the control group takes longer in reducing blood sugar levels, so it can also be said that the intervention group is more effective in reducing blood sugar levels significantly because in addition to the intervention group getting education, they are also given additional in the form of dragon fruit juice. In line with research [14] explained that red dragon fruit (Hylocereus polyrhizus) is believed to reduce blood glucose levels. Red dragon fruit is a plant that comes from a dry tropical climate. Dragon fruit has antioxidant content such as flavonoid

compounds, vitamin C, and polyphenols. Dragon fruit has colour pigments in the form of anthocyanins which are rich in antioxidants. Dragon fruit also contains many substances such as calcium, beta-carotene, vitamin B1, vitamin B2, vitamin C, phosphorus and flavonoid substances. Dragon fruit has potential as a free radical inhibitor because it contains betasianin and helps reduce blood glucose levels and can prevent the risk of heart disease in diabetics. Seeing this, dragon fruit is believed to have the effect of lowering blood glucose levels because dragon fruit contains antioxidant compounds in the form of flavonoids that are protective against damage to beta cells as insulin producers and can increase insulin sensitivity.

Mean and Difference of Blood Sugar Level Reduction between Intervention Group and Control Group

Based on table 5, it shows that the average value of the difference in blood sugar levels in the intervention group is 94.19 mg/dL and the control group is 62.88 mg/dL and the statistical test results between the intervention and control groups obtained a p value of 0.025 <0.05, meaning that there is a significant difference between the intervention group and the control group.

In line with research [36] stated that the average difference in blood sugar levels in the administration of dragon fruit juice was 78.54 mg/dL. The results of the Pairet T-Test test in the red dragon fruit juice intervention group found that the p-value (0.000 <0.05) then H1 is accepted so it can be concluded that there is a difference in blood sugar levels before and after being given red dragon fruit juice therapy in the red dragon fruit juice intervention group.

Another study conducted with the administration of dragon fruit juice in 250 ml effectively lowered blood sugar in line with [37] where the administration of dragon fruit juice as much as 200 grams in 250 ml has been proven effective in reducing blood glucose levels in people with DM compared to the administration of 100 grams of dragon fruit in 250 ml, with an average decrease in glucose levels. There is a difference in the average blood glucose levels in the control group and the intervention group after being given red dragon fruit. The difference in blood glucose levels is possible because in the intervention group respondents were given red dragon fruit which can provide hypoglycaemia effects, while the control group was not given any intervention. Blood glucose levels in the intervention group and control group increased and decreased. In addition, research conducted by [8] there was a decrease in blood glucose in the sample. The decrease occurred in all treatments by giving dragon fruit juice with 200grams per day, the percentage of glucose levels decreased by 9.1-29.1%.

According to observations from researchers, the highest difference in blood sugar levels was found in the average of the intervention group compared to the control group, which means that consuming red dragon fruit juice is greater in reducing blood sugar levels than not consuming red dragon fruit juice.

CONCLUSIONS

There is a significant difference and a decrease in blood sugar levels in patients with diabetes mellitus before and after giving dragon fruit juice. There is a significant difference and a decrease in blood sugar levels in patients with diabetes mellitus before and after education. There is a significant difference in blood sugar levels of patients with diabetes mellitus between the intervention group and the control group with an average decrease in blood sugar levels in the intervention group of 94.88

mg/dL and the control group of 62.88 mg/dL, so it can be said that consuming dragon fruit juice and education can reduce blood sugar levels more effectively than just education.

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