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The Effect Of Providing Snack Bar Vegetable Snacks Combining Sweet Potatoes And Almonds, High-Intensity Interval Training, And *Mindfulness* Therapy On Blood Glucose Control In Type 2 Diabetes Mellitus Patients In Medan Selayang District, Medan City

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ABSTRAC

Fiber is a complex carbohydrate that is good for people with diabetes mellitus. People with diabetes who consume foods high in fiber with a low glycemic index can lower their postprandial glucose and HbA1c levels. This is a quantitative study with a true experimental design and a pretest-posttest randomized control trial. This study analyzed the effect of consuming a snack bar combining purple sweet potatoes and almonds on controlling postprandial blood sugar levels in type 2 diabetes patients. The population in this study consisted of all type 2 diabetes patients in the Medan Selayang District of Medan City, with a sample of productive age (18-59 years). Data analysis was performed using univariate, bivariate, and multivariate methods. The results showed that the snack bar consumed by type 2 DM patients was snack bar F3, which had the highest crude fiber content, a very strong sweet potato aroma, a slightly sweet taste, a soft texture, and a pleasant aftertaste. The results of the two-way ANOVA test showed a difference in blood sugar levels in the treatment before and after consuming a snack bar combination of sweet potato and almonds, high-intensity interval training, and mindfulness therapy for 2 months. There was a significant difference in the average blood sugar levels in the case and control groups before and after treatment.

Keywords: Snack bar, High Intensity Interval Training, Mindfulness Therapy, Blood Sugar Control

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INTRODUCTION

The rapid change in human lifestyle from traditional to modern culture, along with the development of the times and advances in various technologies, is related to transformations in existing disease patterns, especially those related to lifestyle. An unhealthy lifestyle can cause diseases such as hypertension, coronary heart disease, obesity, and diabetes mellitus (DM). DM is a chronic disease characterized by blood sugar levels that exceed the normal limit of (Indonesian Ministry of Health, 2020) .

Diabetes mellitus (DM) is estimated to affect around 530 million adults worldwide, with a global prevalence of 10.5 percent among adults aged 20 to 79 years. Type 2 DM accounts for around 98 percent of global diabetes diagnoses, although this proportion varies greatly between countries (Robertson et.al 2019) . Data reported in 2022 shows that the prevalence of diagnosed DM is around 11.3 percent of adults (95 percent of whom have Type 2 DM). Global data shows that the incidence of Type 2 DM worldwide among adolescents and young adults (aged 15 to 39 years) increased from 117 to 183 per 100,000 population between 1990 and 2019 (Eshete et.al, 2023) .

Data obtained from *the International Diabetes Federation* (IDF) in 2019 shows that Indonesia ranks 7th among the 10 countries with the highest number of patients, namely 10.7 million (Indonesian Ministry of Health, 2020) . Based on data from the 2023 RISKESDAS, the prevalence of diabetes mellitus by province, particularly in North Sumatra province, is 8.47% (North Sumatra Provincial Health Office, 2024) .

Diabetes mellitus itself has risk factors that contribute to the occurrence of the disease, namely non-modifiable risk factors (age, gender, and family history of diabetes mellitus) and modifiable risk factors (excessive body weight, lack of physical activity, hypertension, abnormal blood lipid profile and/or triglycerides > 250 mg/dL, and an unhealthy diet high in sugar and low in fiber) (Ministry of Health of the Republic of Indonesia, 2020) .

Dietary management is an important component of diabetes mellitus control. Carbohydrate intake significantly affects blood sugar levels, although protein and fat intake also contribute to postprandial blood sugar changes when consumed in excess (Bonsembiante et al., 2021).

One method of controlling blood sugar levels is by adhering to the four pillars of diabetes mellitus management, which consist of education, medical nutrition therapy, physical exercise, and pharmacological therapy. Adherence to these four pillars of type 2 diabetes mellitus management will help patients with diabetes mellitus control their blood sugar levels (Perkeni, 2021) .

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Maintaining normal blood sugar levels requires proper and effective diabetes management, particularly regarding dietary patterns. Human eating patterns are an important source of bioactive components, such as vitamins, phenolic compounds, or bioactive peptides. Therefore, these components are beneficial to human health and protect against various diseases. To meet protein requirements, animals are generally considered ideal. However, due to the prevalence of diseases in animals, their consumption is not safe for human health (Ilfada et al., 2024) .

Carbohydrate intake significantly affects blood sugar levels, although protein and fat intake also contribute to postprandial blood sugar changes when consumed in excess (Bonsembiante et al., 2021). Dietary guidelines for Type 2 diabetes patients in Indonesia have been established by the Indonesian Endocrinology Association (PERKENI), where the macronutrient proportions for daily intake for diabetes patients are as follows: carbohydrates 45-65% of total energy, fats 20-25% of total energy, and protein 0.8 g/kg body weight or 10% of total energy requirements (Soelistijo, 2021).

One of the nutritional therapies recommended by Perkeni (2021) to meet plant-based consumption needs is to consume 20-35 grams of fiber per 1000 kcal per day. Fiber is a complex carbohydrate that is good for people with diabetes mellitus. Fiber consumption can make you feel full. Fiber is also low in calories and has a low glycemic index, which can lower blood glucose levels in the body (Perkeni, 2021) .

Fiber consumption is known to prevent blood sugar spikes by slowing digestion and reducing the rate of glucose absorption into the bloodstream. Polyphenols and antioxidants contain anti-inflammatory compounds (Wang, Alkhalidy & Liu, 2021) that combat oxidative stress, which is known to contribute to insulin resistance and worsen glycemic control. Polyphenols can also interfere with glucose absorption or carbohydrate catabolism (Bilal A. Al-Jaidi, Haifa'a Marouf Odetallah, 2020) . This is also in line with the results of a study by Aurelia et al. (2023) that dietary fiber has benefits in controlling blood glucose levels in people with diabetes mellitus and reducing oxidative stress. Diabetes patients who consume high-fiber foods with a low glycemic index can lower postprandial glucose levels and HbA1c in both diabetes mellitus and non-diabetes mellitus patients. Increasing dietary fiber intake can improve glycemic control, body weight, total cholesterol, LDL, and CRP. Increasing daily fiber intake by 15-35 grams per day, regardless of fiber type, is a target for reducing the risk of death from diabetes mellitus (Reynolds, 2020).

Fiber with low calories and a low glycemic index from certain types of legumes and tubers includes almonds and sweet potatoes. Sweet potatoes (*Ipomoea batatas L)* are a type of tuber that has many advantages over other tubers and is the fourth source of carbohydrates in

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Indonesia, after rice, corn, and cassava. Purple sweet potatoes have a higher anthocyanin content compared to other sweet potatoes (Pratiwi, 2020) .

Foods with a low glycemic index (<55) include tempeh, tofu, brown and black rice, mushrooms, tomatoes, red beans, and purple sweet potatoes. In addition, nuts are also known to be high in fiber and protein. Nuts contain complex carbohydrates and have a low glycemic index because they take longer to be converted into glucose, so they do not cause a drastic increase in blood sugar. They are also enriched with magnesium, which helps maintain stable blood sugar levels.

Foods with a low glycemic index (GI), high fiber, and protein are widely recognized as being able to increase insulin sensitivity or stimulate insulin secretion, slow down the movement of food in the digestive tract, and increase enzyme activity; thus, they are beneficial in regulating blood glucose (Manullang et al. 2020).

Therefore, efforts are needed to develop snack bars for people with diabetes mellitus. Snack bars are snacks commonly consumed to stave off hunger between main meals. The advantages of snack bars are that they have a relatively long shelf life and are rich in nutrients (Simanjorang et al., 2020).

Snack bars are generally made from a mixture of dry ingredients such as grains, nuts, and fruits. Snack bars contain balanced nutrients, including protein, fat, minerals, vitamins, calories, and carbohydrates, and can help delay hunger. Snack bars are very popular because they are designed as practical snacks that can be enjoyed during leisure time or to overcome hunger during busy hours. The antioxidant content of snack bars is influenced by the use of raw materials, namely purple sweet potato flour.

The snack bars designed in this study combine purple sweet potato flour and almond flour. Purple sweet potatoes (Ipomoea batatas L.) are a type of tuber that is rich in fiber, antioxidants, and anthocyanin compounds, which act as natural dyes and have high antioxidant activity (Saputri et al., 2021).

METHOD

This type of research is quantitative research with a *true experimental* research design and *a randomized control trial pretest-posttest* research design. This research was conducted systematically in three stages. The first stage of the research was the production of snack bars, which was carried out at the Laboratory of the Faculty of Engineering, Department of Food Technology, at the State University of Medan. The second stage of the research involved organoleptic testing, which was carried out by 15 panelists, followed by an analysis of the fiber content in the snack bars made from a combination of purple sweet

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potatoes and almonds, which was carried out at the Laboratory of the Medan Industrial Standards and Services Center. The third stage of the research was to analyze the effect of giving snack bars combining purple sweet potatoes and almonds on controlling *postprandial* blood sugar levels in type 2 DM patients.

The population in this study consisted of all type 2 DM patients in Medan Selayang District, Medan City, of productive age (18-59 years) in November 2024, totaling 30 people, with 15 people in the case group and 15 people in the control group. The sample size for this study was 30 respondents (15 in the intervention group and 15 in the control group). The data sources used were primary and secondary data. The data collection techniques used were organoleptic testing and fiber content analysis. The data analysis methods used in this study were univariate analysis, bivariate analysis, and multivariate analysis.

RESEARCH RESULTS

Organoleptic Results of Snack Bars

1. Fiber Content

The results of the crude fiber content test on the sweet potato and almond snack bar combination are as follows:

Table 1. Nutritional Content of Sweet Potato and Almond Flour Snack Bar Per 250 Grams using the SNI 01-2891-1992 Test Method

No	Parameter	Unit	F1	F2	F3
1.	Protein	%	2.54	1.15	1.31
2	Ash Content	%	2.62	4.01	3.88
3	Moisture Content	%	3.93	4.54	5.31
4	Crude Fiber	%	25.3	25.3	25.7
5	Carbohydrates	%	34.3	32.6	34.3
6	Total Fat	%	31.2	32.4	29.5

Based on Table 1, the results of laboratory tests at the Medan Industrial Standards and Services Center using the SNI 01-2891-1992 test method show that the snack bar combination of sweet potatoes and almonds with the highest crude fiber content is snack bar sample code formula 3 (F3).

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2. Results of the Snack Bar Combination of Sweet Potato and Almond Acceptance Test (Hedonic and Hedonic Quality)

The sensory evaluation of snack bar preference was conducted by comparing three formulations, namely snack bars:

Formula 1 (F1): A mixture of sweet potato flour and almond flour at a ratio of approximately 25%
(100 g : 15 g)

Formula 2 (F2): A mixture of sweet potato flour and almond flour at a ratio of approximately 50%
(90 g : 20 g)

Formula 3 (F3): A mixture of sweet potato flour and almond flour at a ratio of approximately 75%
(80 g : 30 g)

1) Color

The panelists' acceptance test of the color aspect of sweet potato flour and almond flour snack bars based on subjective evaluations captured by the sense of sight can be seen in Table 2 below:

Table 2. *Snack Bar* Characteristics Based on Color

No	Parameter	Sample Code					
		F1		F2		F3	
		n	%	n	%	n	%
1.	Dark Purple	1	6.7	14	93.3	15	100
2.	Light Purple	14	93.3	1	6.7	0	0
Total		15	100	15	100	15	100

Based on Table 2, the results of the study on the panelists' preference for the color of the sweet potato and almond snack bar combination using the hedonic test in Table 4.4 show that the majority of snack bars with sample code F3 (75% sweet potato flour substitution) stated that the overall dark purple color was 100%.

2) Aroma

Table 3. Characteristics *of Snack Bars* Based on Sweet Potato Aroma

No	Parameter	Sample Code

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		F1		F2		F3	
		n	%	n	%	n	%
1.	Very strong	3	20.0	4	26.7	6	40.0
2	Strong	6	40	6	40.0	4	26.7
3	Somewhat strong	3	20	4	26.7	3	20.0
4.	Not strong	3	20	1	6.7	2	13.3
5.	Very weak	0	0	0	0	0	0
Total		15	100	15	100	15	100

Based on the results of the study on the panelists' preference for the aroma of the sweet potato and almond snack bar combination in Table 3, it shows that the majority of snack bars with sample code F3 stated that the aroma was very strong at 40%.

Table 4. Characteristics of *Snack Bars* Based on the Distinctive Aroma of Almonds

No	**Parameter**	**Sample Code**					
		F1		**F2**		**F3**	
		n	**%**	**n**	**%**	**n**	**%**
1.	Very strong	0	0	0	0	2	13.3
2	Strong	1	6.7	6	40.0	9	60.0
3	Somewhat strong	9	60	7	46.7	4	26.7
4	Not strong	5	33.3	2	13.3	0	0
5	Very weak	0	0	0	0	0	0
Total		**15**	**100**	**15**	**100**	**15**	**100**

The panelists' level of preference for the distinctive aroma of almonds in the sweet potato and almond snack bar combination in Table 4 shows that the majority of snack bars with sample code F3 scored 60%.

3) Sweetness

Table 5. Characteristics of Sweet Potato and Almond *Snack Bar* Combination Based on Sweetness Test

No	**Parameter**	**Sample Code**					
		F1		**F2**		**F3**	
		n	**%**	**n**	**%**	**n**	**%**
1.	Not very sweet	3	20.0	1	6.7	1	6.7
2.	Not sweet	4	26.7	9	60.0	3	20.0

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3	Slightly sweet	8	53.3	4	26.7	6	40.0
4.	Sweet	0	0	1	6.7	5	33.3
5	Very sweet	0	0	0	0	0	0
Total		**15**	**100**	**15**	**100**	**15**	**100**

The panelists' preference for the sweetness of the sweet potato and almond snack bar combination in Table 5 shows that the majority of snack bars with sample code F2 were rated as very strong at 60%.

4) Texture

Table 6. Characteristics of Sweet Potato and Almond *Snack Bars* Based on Texture

No	**Parameter**	**Sample Code**					
		F1		**F2**		**F3**	
		n	**%**	**n**	**%**	**n**	**%**
1.	Very hard	0	0	0	0	0	0
2.	Hard	3	20.0	4	26.7	3	20.0
3.	Somewhat hard	7	46.7	6	40.0	5	33.3
4.	Not hard	5	33.3	5	33.3	7	46.7
5.	Crispy	0	0	0	0	0	0
Total		**15**	**100**	**15**	**100**	**15**	**100**

The texture of the sweet potato and almond snack bar combination in Table 6 shows that the majority of snack bars with sample code F3 were not hard (46.7%).

5) *Aftertaste*

Table 7. Characteristics of Sweet Potato and Almond *Snack Bars* Based on *Aftertaste*

No	**Parameter**	**Sample Code**		
		F1	**F2**	**F3**

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		n	%	n	%	n	%
1.	Strongly dislike	0	0	0	0	0	0
2.	Don't like	6	40.0	5	33.3	5	33.3
3	Somewhat like	5	33.3	5	33.3	4	26.7
4	Like	4	26.7	5	33.3	6	40.0
5	Very much like	0	0	0	0	0	0
Total		**15**	**100**	**15**	**100**	**15**	**100**

The results of the study show that the panelists' level of liking for *the sweet* potato and almond snack bar combination in Table 7 indicates that the majority of snack bars with sample code F3 were liked by 40.0%.

Administration of Sweet Potato and Almond Snack Bars, High-Intensity Interval Training, and *Mindfulness* Therapy

The results of the study on the administration of sweet potato and almond *snack bars*, high-intensity interval training, and *mindfulness* therapy for one month in type 2 diabetes patients are described as follows:

Table 8. Blood Glucose Level Measurements Before and After the Administration of Sweet Potato and Almond *Snack Bars*, High-Intensity Interval Training, and *Mindfulness* Therapy in Type 2 Diabetes Patients Over a One-Month Period in the Case Group in Medan Selayang District in 2025

No	Blood Glucose Levels After 1 Month of Intervention in Cases	Mean	SD	$t_{calculated}$	P_{value}
1.	*Pre*	310.93	72.821	2.827	0.013
2	*Post*	303.73	72,369		

Based on Table 8, the t-test results show that the average blood sugar level in type 2 DM patients for 1 month before treatment was 310.93 and after treatment decreased to 303.73, a decrease of 7.2. Furthermore, based on the t-test, the calculated t-value was 2.827 with a significance of 0.013. From the data above, it can be concluded that the decrease in blood sugar levels in type 2 DM patients was 7.2, indicating a significant decrease.

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The administration of *a snack bar* combining sweet potatoes and almonds, high-intensity interval training, and *mindfulness* therapy for two months in type 2 DM patients is described as follows:

Table 9. Results of Blood Sugar Level Measurements Before and After the Administration of Sweet Potato and Almond *Snack Bars*, High-Intensity Interval Training, and *Mindfulness* Therapy in Type 2 DM Patients for 2 Months in Medan Selayang District in 2025

No	Blood Glucose Levels After 2 Months of Intervention in Cases	Mean	SD	t calculated	P value
1.	*Pre*	255.60	62.625	7.019	0.000
2	*Post*	237.67	66,352		

Based on Table 9, the t-test results show that the average blood sugar level in type 2 DM patients over 2 months was 255.60 before treatment and decreased to 237.67 after treatment, a decrease of 17.93. Furthermore, based on the t-test, the t-value was 7.019 with a significance of 0.000. From the above data, it can be concluded that the decrease in blood sugar levels in type 2 DM patients was 17.93, indicating a significant decrease.

The administration of *a snack bar* combining sweet potatoes and almonds, high-intensity interval training, and *mindfulness* therapy for 1 month in the control group is described as follows:

Table 10. Results of Blood Sugar Level Measurements Before and After the Administration of Sweet Potato and Almond *Snack Bars*, High-Intensity Interval Training, and *Mindfulness* Therapy in the Control Group for One Month in Medan Selayang District in 2025

No	Blood Glucose Levels After 1 Month of Treatment in the Control Group	Mean	SD	t calculated	P value
1.	*Pre*	113.40	13.010	4.638	0.000
2	*Post*	98.07	11,291		

Based on Table 10, the t-test results show that the average blood sugar level in the control group for 1 month before treatment was 113.40 and after treatment decreased to 98.07, a

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decrease of 15.33. Furthermore, based on the t-test, the t-value was 4.638 with a significance of 0.000. From the above data, it can be concluded that the decrease in blood sugar levels in type 2 DM patients was 15.33, indicating a significant decrease.

The administration of *a snack bar* combination of sweet potatoes and almonds, high-intensity interval training, and *mindfulness* therapy for 2 months in the control group is described as follows:

Table 11. Results of Blood Sugar Level Measurements Before and After the Administration of Sweet Potato and Almond *Snack Bars*, High-Intensity Interval Training, and *Mindfulness* Therapy in the Control Group for 2 Months in Medan Selayang District in 2025

No	Blood Glucose Levels During the 2-Month Intervention in the Control Group	Mean	SD	t calculated	P value
1.	*Pre*	110.47	12.380	15.509	0.000
2	*Post*	99.40	11,489		

Based on the t-test results, the average blood sugar level in non-DM patients over 2 months before treatment was 110.47 and decreased to 99.40 after treatment, resulting in a decrease of 11.07. Furthermore, based on the t-test, the calculated t-value was 15.509 with a significance of 0.000. From the data above, it can be concluded that the decrease in blood sugar levels in type 2 DM patients was 11.07, indicating a significant decrease.

The results of the *two-way ANOVA* test to determine the difference in blood sugar levels in type 2 DM patients (cases) and non-DM (controls) before and after consuming a snack bar combination of sweet potatoes and almonds, performing high-intensity interval training and mindfulness for 1 month are described as follows:

Table 12. Results of Testing Blood Sugar Level Differences in Cases and Controls Over 1 Month Before and After Consuming Sweet Potato and Almond Snack Bars, High-Intensity Interval Training, and *Mindfulness* Therapy

Treatment				
	Treatment	*Mean*	*Std. Deviation*	N
Cases	*Pre*	310.93	72.821	15

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	Post	303,73	72,369	15
	Total	307.33	71,427	30
Control	*Pre*	113.40	13,010	15
	Post	98.07	11,291	15
	Total	105.73	14,285	30

Based on Table 12, blood sugar levels during one month in the case group (type 2 DM patients) before treatment had an average value of 310.93 mg/dl and after treatment 303.73 mg/dl, while the average blood sugar level in the control group (non-DM) was 113.40 mg/dl before treatment and 98.07 mg/dl after treatment. This means that in the case group, there was a decrease in blood sugar levels of 7.2 points, and in the control group, there was a decrease in blood sugar levels of 15.33 points.

From these results, it can be concluded that there was a decrease of approximately 7.2 points in blood sugar levels with the administration of a snack bar combination of sweet potatoes and almonds, high-intensity interval training, and mindfulness therapy before and after treatment in the case group for one month.

Table 13. Test Results with Two-Way Analysis of Variance (*Two-Way ANOVA*) Differences in Blood Sugar Levels in Cases and Controls for 1 Month Before and After Consumption of Sweet Potato and Almond Snack Bars, High-Intensity Interval Training, and *Mindfulness* Therapy

Source	***Type III Sum of Squares***	***df***	***Mean Square***	***F***	***Sig.***
Corrected Model	611790.533[a]	3	203,930.178	75,273	0.000
Intercept	2,559,361.067	1	2,559,361.067	944,685	0.000
Treatment	609,638.40	1	609,638.400	225,023	0.000
Period	1,904,067	1	1,904,067	0.703	0.405
*Treatment*Periode*	248,067	1	248,067	0.092	0.763
Error	151,716.400	56	2,709.221		
Total	3,322,868.00	60			
Corrected Total	763,506.933	59			

Based on Table 13 above, it shows that the significance value for the *pre-* and *post-treatment* categories obtained Sig. 0.000 < 0.05, so H0 is rejected. This indicates that there is

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a difference in blood sugar levels in the treatment before and after consuming a snack bar combination of sweet potatoes and almonds, high-intensity interval training, and mindfulness therapy for 1 month. Based on the average blood sugar levels in the case and control groups before and after treatment, the results were different.

To see the interaction between the case and control groups before and after treatment for 1 month, see the row "treatment*period" From the table, the *sig* value is 0.763 > 0.05, so H0 is accepted, and it can be concluded that there is no interaction between *pre-* and *post-treatment* with treatment time.

Table 14. Results of Testing Blood Sugar Level Differences in Cases and Controls for 1 Month Before and After Consuming Sweet Potato and Almond Snack Bars, High-Intensity Interval Training, and *Mindfulness* Therapy

Treatment	*Treatment*	*Mean*	*Std. Deviation*	N
Cases	*Pre*	255.60	62.625	15
	Post	237.67	66,352	15
	Total	246.63	64,046	30
Control	*Pre*	110.47	12,380	15
	Post	99.40	11,849	15
	Total	104.93	13,170	30

In Table 14 above, the blood sugar levels over one month in the case group (type 2 DM patients) before treatment had an average value of 255.60 mg/dl and after treatment 237.67 mg/dl, while the average blood sugar level in the control group (non-DM) was 110.47 mg/dL before treatment and 99.40 mg/dL after treatment. This indicates a decrease in blood sugar levels of 17.93 points in the case group and a decrease of 11.07 points in the control group.

Table 15. Results of *Two-Way ANOVA* Testing Differences in Blood Sugar Levels in Cases and Controls Over 2 Months Before and After Consumption of Sweet Potato and Almond Snack Bars, High-Intensity Interval Training, and *Mindfulness* Therapy

Source	***Type III Sum of Squares***	***df***	***Mean Square***	***F***	***Sig.***
Corrected Model	304513.917[a]	3	101,504.639	47,113	0
Intercept	1853986.817	1	1853986.817	860,516	0.000

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Treatment	301,183.350	1	301,183.350	139,792	0.000
Period	3,153,750	1	3,153,750	1,464	0.231
*Treatment*Period*	176,817	1	176,817	0.082	0.776
Error	120,652.267	56	2,154.505		
Total	2,279,153.00	60			
Corrected Total	425,166.183	59			

Based on Table 15 above, it shows that the significance value for the pre- and post-treatment categories obtained Sig. 0.000 < 0.05, so H0 is rejected. This indicates that there is a difference in blood sugar levels in the treatment before and after consuming a snack bar combination of sweet potatoes and almonds, high-intensity interval training, and mindfulness therapy. Based on the average blood sugar levels in the case and control groups before and after treatment, the results were different over a 2-month period.

From these results, it can be concluded that there is a difference in blood sugar levels with the administration of sweet potato and almond snack bars, high-intensity interval training, and mindfulness therapy before and after treatment in the case and control groups for two months.

To see the interaction between the case and control groups before and after treatment for one month, refer to the "treatment*period" row from the table, the Sig. value is 0.776 > 0.05, so H0 is accepted, and it can be concluded that there is no interaction between pre- and post-treatment with treatment time.

DISCUSSION

1. Fiber Content of Plant-Based Snack Bars Combining Sweet Potatoes and Almonds

The fiber content of the plant-based snack bar combining sweet potatoes and almonds from the F3 product given to type 2 diabetes patients contains 25.7 grams of crude fiber **in 250 grams of product**, or equivalent to **10.28% (10.28 g per 100 g)**. This value is classified as **high fiber,** because according to **BPOM** standards, **the ideal crude fiber** content **is 36%.** High fiber foods such as **sweet potatoes and almonds** are known to contain cellulose, hemicellulose, lignin, and some soluble fibers such as pectin and β-glucan. Measured crude fiber represents the insoluble fiber fraction that cannot be digested by digestive enzymes, but plays an important role in **increasing fecal mass, facilitating digestion,** and **increasing satiety.**

Plant-based *snack bars* combining sweet potatoes and almonds were given to type 2 DM patients in amounts of 30 grams, with each *snack bar* weighing 10 grams. *The snack bars* were given as a snack to type *2* DM patients after checking their blood sugar levels, with fasting

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beforehand starting at 10:00 p.m. This is supported by the findings of Reynolds, Akerman & Mann (2020), who stated that daily fiber intake of 15-35 grams per day, regardless of fiber type, is a target for reducing the risk of death from diabetes mellitus (Reynolds, Akerman & Mann, 2020) . This is also confirmed by the results of a study by Reynolds et al. (2020) that increasing daily fiber intake (15-35 g) can improve glycemic control measures, such as HbA1c, FPG, insulin, and *Homeostatic Model Assessment of Insulin Resistance* (HOMA-IR).

Results from interviews with type 2 diabetes patients after one week of consuming *a* plant-based *snack bar* combining sweet potatoes and almonds indicated they felt less hungry even without breakfast before engaging in high-intensity interval training and *mindfulness* therapy. This aligns with the findings of the study " , which indicates that for individuals **with type 2 diabetes,** consuming high-fiber foods like these snack bars provides significant physiological benefits.

2. Level of Preference for *the* Plant-Based *Snack Bar* Combining Sweet Potato and Almond

Based on evaluations from 15 panelists, the preference level for the plant-based snack bar combining sweet potato and almond was found to be highest for product F3 (Formula 3), which had a mixing ratio of sweet potato flour and almond flour of approximately 75% (80 g : 30 g) had the highest crude fiber content at 25.7% compared to Formula 1 (F1) and Formula 2 (F2). Based on color, the majority of F3 *snack bars* were 100% dark purple, with a very strong sweet potato aroma (40%), a slightly sweet taste (60%), a non-hard texture (46.7%), and *an aftertaste* that was liked by 40%. The plant-based snack bar combining sweet potato and almonds given to type 2 diabetes patients after blood sugar level checks is the F3 snack bar.

Aftertaste is the flavor that most influences consumer preference for plant-based snack bars combining sweet potatoes and almonds. *Aftertaste* is influenced by the composition of the ingredients used in the product. *Aftertaste* in snack bars is influenced by the ingredients used. Raw purple sweet potatoes will give the final product *a* bitter *aftertaste*, which can interfere with the taste of the product. This is in line with the results of research by Sari et al. (2022), which found that the higher the proportion of purple sweet potato flour added, the less the panelists tended to like the resulting product. The *aftertaste* is caused by phenolic compounds and alkaloids found in purple sweet potato flour.

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3. The Effect of *Snack* Bar Combination of Sweet Potato and Almond, High-Intensity Interval Training, and *Mindfulness* Therapy on Blood Sugar Control in Type 2 DM Patients

Blood sugar levels over one month in the case group (type 2 DM patients) before treatment had an average value of 310.93 mg/dl and after treatment 303.73 mg/dl, while the average blood sugar level in the control group (non-DM) before treatment was 113.40 mg/dl and after treatment 98.07 mg/dl. This means that in the case group, there was a decrease in blood sugar levels of 7.2 points, and in the control group, there was a decrease in blood sugar levels of 15.33 points.

The blood sugar level in the control group during 1 month, before treatment, was 113.40 and after treatment decreased to 98.07, so the decrease was 15.33. Furthermore, based on the t-test, the t-value was 4.638 with a significance of 0.000. From the data above, it can be concluded that the decrease in blood sugar levels in type 2 DM patients was 15.33, or a significant decrease. The significance value for the *pre-* and *post-treatment* categories was Sig. 0.000 < 0.05, so H0 was rejected. This indicates that there is a difference in blood sugar levels in the treatment before and after consuming a snack bar combination of sweet potatoes and almonds, high-intensity interval training, and mindfulness therapy for 1 month. Based on the average blood sugar levels in the case and control groups before and after treatment, the results show a difference.To see the interaction between the case and control groups before and after treatment for 1 month, see the row "treatment*treatment." From the table, a *sig* value of 0.763 > 0.05 is obtained, so H0 is accepted, and it can be concluded that there is no interaction between *pre-* and *post-treatment* with treatment time.

Blood sugar levels during 2 months in the case group (type 2 DM patients) before treatment with an average value of 255.60 mg/dl and after treatment 237.67 mg/dl, then the average blood sugar level in the control group (non-DM) before treatment 110.47 mg/dl and after treatment 99.40 mg/dl. This means that in the case group, there was a decrease in blood sugar levels of 17.93 points, and in the control group, there was a decrease in blood sugar levels of 11.07 points. The significance value for the pre- and post-treatment categories over 2 months was obtained as Sig. 0.000 < 0.05, so H0 was rejected. This indicates that there is a difference in blood sugar levels before and after consuming the sweet potato and almond snack bar combination, high-intensity interval training, and mindfulness therapy. Based on the average blood sugar levels in the case and control groups before and after treatment, the results were different over 2 months.

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CONCLUSION

The conclusion that can be drawn from this study is that the fiber content of plant-based snack bars combining sweet potatoes and almonds, based on laboratory test results at the Medan Industrial Standardization and Service Center using the SNI 01-2891-1992 test method, shows that the crude fiber content in 250 mg of product is as follows: formula 1 (F1) 25.3%, Formula 2 (F2) 25.3%, and Formula 3 (F3) 25.7%. For snack bars consumed by type 2 diabetes patients, snack bar F3 has the highest crude fiber content. The level of preference for *the* vegetable *snack bar* combining sweet potatoes and almonds was formula F3 based on the answers of 15 panelists. Based on color, 100% stated dark purple, with a very strong sweet potato aroma of 40%, a slightly sweet taste of 60%, a texture that was not hard of 46.7%, and *an aftertaste* that they liked of 40%. There was a significant decrease in blood sugar levels in type-2 diabetes patients of 15.33%. The significance value of the *pre-* and *post*-treatment was obtained as Sig. 0.000, meaning that there was a difference in blood sugar levels before and after consuming the sweet potato and almond snack bar, high-intensity interval training, and mindfulness therapy for 1 month. Based on the average blood sugar levels in the case and control groups before and after treatment, the results were different. Blood sugar levels over 2 months in the case group (type 2 DM patients) before treatment had an average value of 255.60 mg/dl and after treatment 237.67 mg/dl, while the average blood sugar level in the control group (non-DM) before treatment was 110.47 mg/dl and after treatment 99.40 mg/dl. This indicates a decrease in blood sugar levels of 17.93 points in the case group and a decrease of 11.07 points in the control group.

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