

Research Article

Impact of Soybean (*Glycine max*) Sprout Juice Consumption on Blood Glucose of Individuals with Type 2 Diabetes Mellitus

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ABSTRACT

This study investigated the effect of soybean sprout (*Glycine max*) juice on postprandial blood glucose responses in patients with Type 2 Diabetes Mellitus (T2DM) compared with conventional soybean juice. The prevalence of diabetes mellitus in Indonesia continues to increase, highlighting the need for alternative nutritional interventions. Soybean sprouts are known to have improved nutritional quality and bioavailability, containing protein, dietary fiber, isoflavones, antioxidants, and other bioactive compounds that may support glycemic control. A quasi-experimental study with a pretest–posttest control group design was conducted involving 26 patients with T2DM. Participants were randomly assigned to either a treatment group or a control group. The treatment group received soybean sprout juice, a beverage made from soybean sprouts combined with ginger, palm sugar, pandan, and cinnamon, while the control group received regular soybean juice. Blood glucose levels were measured at baseline (0 minutes) and at 60 and 120 minutes after consumption. The results showed a significant reduction in blood glucose levels in the treatment group compared to the control group ($p < 0.05$). The average decrease in blood glucose levels in the soybean sprout juice group was 16.08 mg/dL at 60 minutes and 54.92 mg/dL at 120 minutes. Measurements at different time points reflected fasting glucose levels, peak postprandial glucose response, and glucose clearance associated with insulin activity. Overall, soybean sprout juice demonstrated a greater ability to reduce postprandial blood glucose levels than regular soybean juice in patients with T2DM. The combination of bioactive compounds in soybean sprouts and added spices may improve insulin sensitivity and delay glucose absorption. Soybean sprout juice shows potential as a functional beverage and may be consumed approximately 15 minutes before meals as a supportive dietary strategy for glycemic management in individuals with type 2 diabetes mellitus.

INTRODUCTION

Diabetes mellitus is a metabolic disease characterized by hyperglycemia due to decreased insulin function or insulin secretion by pancreatic beta cells (IDF 2019). The number of people with diabetes mellitus worldwide in 2021 increased to 537 million people aged 20–79 years with a total mortality of 6.7 million (IDF 2021). The prevalence of diabetes mellitus in 2018 based on doctor's diagnoses increased by 2% from 1.8% in

2013 at the age of >15 years. East Java Province ranks fifth in Indonesia at 2.6% with an age range of 65–74 years. The number of people with diabetes mellitus in Malang City has increased every year from 2019 by 21,527 people to 2022 by 22,227 people (Malang City Health Office 2023).

Diabetes mellitus requires the management of blood glucose, one of which is by regulating one's diet. Consuming protein and fiber can help control blood glucose levels (Purnama *et al.* 2018).

Soybeans (*Glycine max*) contain total dietary fiber of 5.56–8.58%, with 1.52–3.28% soluble and 3.58–6.09% insoluble fiber (Ratnaningsih 2017). In addition, soybeans have a glycemic index of 31, which is classified as low (Rakhmawati *et al.* 2014). Consuming 200 mL of soybean milk can reduce blood glucose levels from 213.30 mg/dL to 105.40 mg/dL (Laboro *et al.* 2023). A decrease in blood glucose of 17.96–26.30 mg/dL also occurred after giving soybean milk and soybean juice formulas (Wagustina 2021).

Soybeans that have undergone germination contain higher protein and have better digestibility due to macromolecular breakdown in the form of protein synthesis (Setiawan *et al.* 2016). Soybean germination for 24 hours is the most optimal germination and has a moisture content of 0.05%, protein content of 0.02%, and the highest protein digestibility value of 0.91% (Mardiyanto & Sudarwati 2015). Here is the English translation with a clear academic tone. The study conducted by Wagustina (2021) demonstrated that supplementation with roasted soybean powder at a dose of 69 g/day for four weeks significantly reduced fasting blood glucose and 2-hour postprandial glucose in individuals with type 2 diabetes mellitus. In addition, a quasi-experimental study in Indonesia reported that both soybean juice and soybean-based formulas were able to significantly reduce blood glucose levels after 14 days in patients with type 2 diabetes mellitus. Furthermore, *in vitro* studies on peptides derived from germinated soybeans have shown inhibitory activity against DPP-IV and carbohydrate-digesting enzymes, indicating a mechanistic basis that may contribute to glycemic regulation (González-Montoya *et al.* 2018).

This shows that soybean sprouts are able to reduce blood glucose in patients with diabetes mellitus type 2. Processing soybean sprouts into soybean sprout mixed juice (soybean sprout juice) with the addition of natural ingredients such as ginger, palm sugar, pandanus, and cinnamon that have antidiabetic effects has the potential to increase the benefits of soybean sprout juice.

Ginger contains flavonoids and phenol compounds that function as antidiabetics (Yanto *et al.* 2016). Palm sugar has a lower glycemic index value compared to granulated sugar (Aprilia & Suryana 2022). The use of Pandan palm sugar contains tannins, alkaloids, and flavonoids can reduce blood glucose (Pasaribu 2018). Cinnamon contains flavonoids, saponins, and polyphenols

that can control blood sugar levels (Yuliastuti *et al.* 2022). This study aimed to examine The Effect of soybean sprout juice (soybean sprouts mixed juice with ginger, palm sugar, pandan, and cinnamon) on blood glucose response in patients with type 2 diabetes mellitus.

METHODS

Design, location, and time

This study employed a quasi-experimental design with a quantitative approach using a pretest–posttest control group design. Subjects were allocated into an intervention group and a control group. Fasting Blood Glucose (FBG) levels were measured before and after the intervention. The intervention group received soybean sprout juice, while the control group received soybean juice, each at a volume of 228 mL with comparable energy content. This research has been declared ‘Ethically Feasible’ by the Ethics Commission of the Poltekkes Kemenkes Malang, in letter No.DP.04.03/F.XXI.31/0679/2024 issued on 25 June 2024. Prior to intervention and sample collection, all participants were given a detailed explanation of the research procedures and possible risks, and voluntary provided written consent.

Sampling

The study population comprised outpatients aged 45–75 years diagnosed with type 2 diabetes mellitus and having fasting blood glucose levels >126 mg/dL. Subjects were recruited using purposive sampling based on predefined inclusion and exclusion criteria.

Inclusion criteria are the criteria used to assess a person's eligibility for inclusion in the sample. These criteria include: 1) Patients with type 2 diabetes mellitus with or without complications of hypertension (both men and women); 2) Aged 45–75 years; 3) Patients must be conscious, able to read and write, and able to hear and speak clearly; 4) Taking antidiabetic medication (sulfonylureas, metformin, etc.); 5) Not currently undergoing insulin therapy; Not allergic to nuts; 7) Light activity (walking, cycling, yoga, gardening, dancing, light household chores such as cleaning); and 8) Willingness to participate in the study after being explained and obtaining informed consent. Exclusion criteria are the criteria used to determine whether a person is excluded from the research sample,

namely; 1) The patient is ill or absent (traveling, moving, or deceased) during data collection; 2) The patient requires special care during data collection; and 3) The patient is unwilling to properly participate in data collection, including identity, characteristics, and blood glucose levels.

The sample size was determined using the formula proposed by Charan and Biswas (2013) for comparisons between two independent groups. In this formula, n represents the minimum required sample size per group, r denotes the ratio of sample sizes between the groups, SD indicates the standard deviation, $Z\beta$ corresponds to the standard normal deviate for the desired statistical power, $Z\alpha/2$ represents the standard normal deviate associated with the selected level of significance, and d refers to the expected difference in mean values between the groups.

Based on previous research, the standard deviation was 7.53 and the expected mean difference was 8.34 mg/dL. Assuming a two-sided significance level of 5% ($Z\alpha/2=1.96$), a statistical power of 80% ($Z\beta=0.84$), and an equal allocation ratio between groups ($r=1$), the minimum required sample size was calculated to be 12.7 participants per group. This value was rounded up to 13 participants per group, resulting in a total sample size of 26 participants (Wagustina 2021).

Data collection

The completion of the questionnaire through direct interviews includes data on the identity and characteristics of the respondents, which consist of name, age, gender, address, family medical history, comorbidities, medications taken, duration of diabetes mellitus, education, and occupation directly. Blood pressure measurement of patients using a digital sphygmomanometer. Nutritional status assessment of patients using BMI obtained from direct measurements of weight and height. Weight measurement using a standing scale and height measurement using a microtoise. Examination of fasting blood glucose levels and blood glucose levels post-meal. Blood sugar levels are measured from capillary blood.

The treatment group was given 228 mL soybean sprout juice and the control group was given 228 mL soybean mixed juice with additional ingredients (ginger, palm sugar, pandan, and cinnamon). This study was conducted in October-November 2024 at Puskesmas Mulyorejo Malang City on patients. The intervention was

conducted once before meals and blood glucose was measured using a glucometer at 0 minutes (fasting), 60, and 120 after consumption. Each participant was required to fast before checking their blood sugar (to see the 0 blood sugar) after which the participants were given an intervention according to their group (the control was given soybean juice and the treatment was given soybean sprout mixed juice) then their blood sugar levels were measured again at 60 and 120 minutes. The ingredients used included a variety of Grobogan soybeans (570 g), water, sugar (168 g), palm sugar (171 g), pandan (1.71 g), ginger (17.1 g), and cinnamon (0.171 g).

The process of making soybean sprout mixed juice begins with selecting and washing dried soybeans, then soaking them for 8 hours to activate enzymes and soften the beans. The quality of the soybeans is determined by observing their condition after washing and soaking them in water. If the soybeans float, they must be discarded and cannot be used. After soaking, the soybeans are germinated in a closed container for 24 hours, with watering every 6 hours, until sprouts appear. The sprouts are then soaked in warm water for 5 minutes to facilitate skin removal, then washed again until clean. Next, the sprouts are ground with water in a 1:6 ratio and filtered to obtain the sprout juice. This juice is heated at 70°C for 20 minutes without boiling, then 0.5% ginger, 0.05% pandan leaves, and 0.005% cinnamon are added, followed by another 10 minutes of heating. After that, 5% liquid palm sugar is added as a natural sweetener. The final mixture is filtered again to produce clear soybean sprout mixed juice, which is then packaged into sterile bottles for storage or distribution even though participants received freshly prepared.

Data analysis

Data were analyzed using SPSS ver.25. Normality test was carried out with Shapiro-Wilk. Followed t-test to compare between groups, and Mixed Design ANOVA to see the effect between measurement times at a significance level of 95% ($p<0.05$). The study involved three groups: the 0-minute group, the 60-minute group, and the 120-minute group. Therefore, the post-hoc test used was Simple Main Effects with correction Bonferroni to show the effect of soybean sprout juice (soya sprout juice) and soybean juice on blood glucose response in patients with type 2 diabetes mellitus.

RESULTS AND DISCUSSION

Table 1 shows the characteristics of respondents in the form of age 45–75 years, gender, nutritional status based on Body Mass Index (BMI), fasting blood glucose levels, family history of disease, history of comorbidities, medications consumed, duration of diabetes mellitus, education, and occupation. The statistical test results of respondents' characteristics showed a $p > 0.05$, which means there was no significant difference between the treatment group and the control group.

The majority of respondents had an age range of 56–65 years, amounting to 12 participants (46.2%) (Table 1). With increasing age, pancreatic β -cells will shrink, causing blood glucose to rise due to the small amount of insulin hormone produced (Masruroh 2018). Most participants were female, (18 participants, (69.2%) (Table 1). In Indonesia, women suffer more from diabetes mellitus, which is 1.8%, while men are only 1.2% (MoH RI 2020). Most respondents had a nutritional status of overweight/obesity, namely 15 respondents (57.7%) (Table 1). The average body mass index of respondents categorized as obese is 25.77 kg/m² (Masruroh 2018). Fasting blood glucose data from 26 respondents, most of which are 19 respondents (73.1%) still have blood glucose > 126 mg/dL (Table 1). The majority of respondents did not have a family history of the disease as many as 14 respondents (53.8%) (Table 1). Diabetes mellitus is caused by an unhealthy diet and low physical activity (Hariawan *et al.* 2019).

Most respondents (69.2) had comorbidities. Uncontrolled blood glucose levels can cause various disease complications in type 2 diabetes mellitus (Setiyorini *et al.* 2018). Most consumed diabetes mellitus drugs with a combination (53.8%). The majority of respondents (53.9%) had a long illness with diabetes mellitus for ≤ 5 years. The majority of respondents (53.8%) had primary education, and did not work (61.5%).

The increasing age of pancreatic β -cells will experience progressive shrinkage, so that the insulin hormone produced is small and causes blood glucose to rise (Masruroh 2018). Women are more at risk of developing diabetes mellitus because physically women have a greater chance of increasing body mass index. Estrogen hormone changes in the premenstrual, post-menopausal, and pregnancy cycles make body fat more easily

accumulated due to increased appetite, so that the body cannot receive direct calorie intake and use it in total, resulting in an increase in blood glucose levels. Overnutrition status can trigger an increase in blood glucose levels because the body becomes fat due to fat deposits in the body caused by lack of activity and excessive intake of incoming food so that calories are not burned into energy (Priasmara 2015). Overweight or obesity causes increased production of resistin which can cause insulin resistance by interfering with the work of insulin (Masruroh 2018).

Children who have parents with diabetes mellitus are at greater risk of developing diabetes mellitus than children whose parents do not have diabetes mellitus (Rediningsih & Lestari 2022). Diabetes mellitus is also caused by an unhealthy diet and low physical activity (Hariawan *et al.* 2019). Uncontrolled blood glucose levels can cause various disease complications in type 2 diabetes mellitus, one of which is hypertension (Setiyorini *et al.* 2018). Adherence to taking medication is influenced by several factors such as education, modification, changes in therapy models, increasing interactions, knowledge, age, and family support (Bulu *et al.* 2019). Low knowledge makes respondents less understanding of the care needed (Roifah 2017). Low education has a risk of low knowledge and awareness in maintaining a healthy lifestyle and a healthy diet to prevent diabetes mellitus (Pahlawati & Nugroho 2019). Working with light/low physical activity causes a lack of energy burning in the body so that excess energy will be stored in the form of fat in the body which causes obesity which is one of the factors for diabetes mellitus (Arania *et al.* 2021).

Table 2 describes the average decrease in blood glucose levels at 60 and 120 minutes after being given soybean sprout juice and soybean juice. Statistical test results obtained $p < 0.05$ ($p = 0.033$) which means that there is a significant difference between blood glucose levels at minutes 0, 60, and 120 after consumption of soybean sprout juice while in the administration of soybean juice, there is no significant difference.

Table 3 presents the changes in blood glucose levels among patients with type 2 diabetes mellitus after receiving soybean sprout juice (soybean sprout mixed juice) or soybean juice. Statistical analysis showed that soybean sprout juice produced a significant reduction in blood glucose levels ($p = 0.004$), while soybean

The effect of “Soybean Sprout Extract” on blood glucose response

Table 1. Characteristics of the respondents

Characteristic (n=26)	Intervention	Control	p*
	n (%)	n (%)	
Age (years)			
45–55	3 (21.3)	3 (23.1)	0.430
56–65	5 (38.5)	7 (53.8)	
65–75	5 (38.5)	3 (23.1)	
Gender			
Man	3 (23.1)	5 (38.5)	0.511
Woman	10 (76.9)	8 (61.5)	
Nutritional status			
Underweight (BMI<18.5)	1 (7.7)	1 (7.7)	0.360
Normal (BMI 18.5–25)	4 (30.8)	5 (38.5)	
Overweight (BMI>25)	8 (61.5)	7 (53.8)	
Fasting blood glucose			
70–99 mg/dL	0 (0.0)	0 (0.0)	0.650
100–125 mg/dL	3 (23.1)	4 (30.8)	
>126 mg/dL	10 (76.9)	9 (69.2)	
Family History			
Yes	7 (53.8)	5 (38.5)	0.511
No	6 (46.2)	8 (61.5)	
Comorbidities			
Yes	9 (69.2)	9 (69.2)	1.000
No	4 (30.8)	4 (30.8)	
Drug			
Metformin	4 (30.8)	6 (46.2)	0.762
Sulfonylurea	1 (7.7)	0 (0.0)	
Glimepiride	1 (7.7)	0 (0.0)	
Combination	7 (53.8)	7 (53.8)	
Duration of DMT2			
≤5 years	8 (61.5)	6 (46.2)	0.687
6–10 years	3 (23.1)	6 (46.2)	
>10 years	2 (15.4)	1 (7.7)	
Education			
Without formal education	1 (7.7)	1 (7.7)	0.650

Continue from Table 1

Characteristic (n=26)	Intervention	Control	p*
	n (%)	n (%)	
Primary	6 (46.2)	8 (61.5)	
Middle	6 (46.2)	3 (23.1)	
High	0 (0.0)	1 (7.7)	
Occupation			
No occupation	9 (69.2)	7 (53.8)	0.762
Private sector	1 (7.7)	5 (38.5)	
Self employed	3 (23.1)	1 (7.7)	

BMI: Body Mass Index; DMT2: Diabetes Mellitus Type 2; Independent Sample T-Test, p*significance at p<0.05

juice did not produce a statistically significant change (p=0.273).

Further post-hoc analysis indicated that the soybean sprout juice group experienced significant reductions in blood glucose over time, particularly between 0, 60, and 120 minutes. In contrast, the soybean juice group did not show significant changes across the three measurement points. These findings suggest that soybean sprout juice has a more pronounced effect on lowering postprandial blood glucose levels than soybean juice in patients with type 2 diabetes mellitus.

The standard deviation shows a large number because each patient's blood glucose level varies, with some being too high at 373 mg/dL and others too low at 72 mg/dL.

The blood glucose changes of the treatment group were significantly decreased due to the use of palm sugar which has a lower glycemic index value compared to the granulated sugar used in the control group's soya juice, although the energy and carbohydrates in palm sugar are higher than granulated sugar. This is because the main component of granulated sugar is sucrose, a disaccharide resulting from the evaporation of sugarcane sap (*Saccharum officinarum*). Granulated sugar contains 97.1% sucrose, 1.24% reducing sugar, 0.61% water, and 0.7% non-sugar organic compounds (Syakirin 2020). The sucrose content in granulated sugar ranges from 97.44% to 97.50%. This content is very high and consistent between samples and different production periods. In addition, granulated sugar contains almost no reducing sugars, indicating high sucrose purity (Ibrahim *et al.* 2019). Whereas, palm sugar contains 72.87–95.79%

Table 2. Average blood glucose changes among study participants before and after giving soybean sprout extract (soybean sprouts mixed juice) and soybean juice

Variable	Blood glucose changes			
	Treatment		Control	
	mean±SD	<i>p</i>	mean±SD	<i>p</i>
Minute 0	16.08±68.859	0.033*	3.92±50.717	0.326
Minute 60	54.92±44.841		15.08±29.579	

SD: Standard Deviation; Dependent T-Test, significance $p < 0.05$

sucrose, 1.27–1.5% fructose, and 0.78–1.6% glucose, where the sucrose in palm sugar is lower (Assah & Makalalg 2021).

Soybean sprouts contain a distinct and generally higher concentration of bioactive compounds compared to unsprouted soybeans, which may contribute to a stronger effect on blood glucose regulation (Winarsi *et al.* 2019). The germination process increases the levels of isoflavones such as genistein, daidzein, and glycitein, with total isoflavone content in sprouts reaching over 39 ppm, higher than the approximately 26 ppm found in regular soybeans. Germination also enhances phenolic compounds and antioxidant activity, including antiglycation properties that can reduce the formation of Advanced Glycation End Products (AGEs), molecules that contribute to metabolic dysfunction and diabetic complications (Zhou *et al.* 2024). In addition, soybean sprouts contain saponins and may exhibit increased levels of compounds such as GABA, which play roles in improving insulin sensitivity and supporting insulin secretion by pancreatic β -cells (Lu *et al.* 2023). These bioactive components contribute to various mechanisms of glucose-lowering effects, such as reducing oxidative stress, improving insulin responsiveness, and decreasing glucose absorption through the inhibition of

carbohydrate-digesting enzymes. Therefore, the richer bioactive profile of soybean sprouts provides a strong biological rationale for why soybean sprout juice (soybean sprout juice) may exert a more significant glucose-lowering effect than regular soybean juice (Winarsi *et al.* 2019; Zhou *et al.* 2024).

Soybean sprout juice contains many compounds that are beneficial to reducing blood glucose levels, such as protein, isoflavones, antioxidants, vitamins, and high fiber have a good influence on metabolic balance. Research by Mahmoud *et al.* (2016), proved that giving soybean sprouted seeds to diabetic rats can improve weight loss, reduce blood glucose levels, counteract liver and kidney damage to some extent, improve HDL-C decline and LDL-C increase, increase antioxidant activity much better than non-germinated soybeans. Germinated soybeans are better at lowering blood glucose levels than soybeans because germination increases isoflavone content, and enhances the inhibitory action of amylase and glucosidase enzymes (Mahmoud *et al.* 2016). Germinated soybeans have been shown to control hyperglycaemia through inhibition of α -amylase in saliva (Rowaiye *et al.* 2024). It is important to state that the soybean sprout juice formulation in this study was made with ginger,

Table 3. The effect of giving soybean sprout extract (Soybean sprouts) and soybean juice on blood glucose response in type 2 diabetes mellitus patients

Variable	Blood glucose changes			
	Treatment		Control	
	mean±SD	<i>p</i>	mean±SD	<i>p</i>
Minute 0	210.83±65.428 ^a	0.004*	213.92±92.567 ^a	0.273
Minute 60	200.92±82.620 ^{ab}		210.00±90.462 ^a	
Minute 120	144.42±66.392 ^b		194.92±109.762 ^a	

SD: Standard Deviation; One Way Anova, Duncan Test, significance at $p < 0.05$

cinnamon, and pandan, all of which are known to have hypoglycemic activity and may contribute to lowering blood glucose levels. Therefore, the decrease in glucose after soybean sprout juice consumption cannot be considered as caused only by the germination process of soybeans. The results of this study should be understood as the combined effect of soybean sprouts and the additional bioactive ingredients. In future studies, a more controlled design should be used, in which the beverages in the treatment and control groups are given the same non-soy additives, so that the specific effect of germination can be identified more accurately.

The increase in protein levels during the germination process is due to the formation of essential amino acids, which are protein constituent compounds needed during germination (Aminah 2020). Soybeans also contain isoflavones genistein and daidzein which inhibit α -glucosidase activity that can slow down the process of converting carbohydrates into glucose (Anggraeni *et al.* 2023). Isoflavones contain flavonoid compounds, where flavonoids increase the rate of lipid peroxides that prevent pancreatic β -cell damage in diabetic rats so as to reduce blood glucose levels (Rakhmawati *et al.* 2014). The mechanism of isoflavones in soybeans is to increase insulin resistance and reduce body fat and blood lipid levels that affect fatty acid metabolism and cholesterol homeostasis (Yulistianingsih & Kartini 2014).

Soybean germination for 24 hours is the most optimal time (Mardiyanto & Sudarwati 2015). Antioxidant activity in the treatment of germination time showed results that tended to increase in the treatment of germination time of 24, 32, and 40 hours, namely 22.34 $\mu\text{g/mL}$, 22.61 $\mu\text{g/mL}$ and 24.51 $\mu\text{g/mL}$ but decreased at 48 hours, namely 21.45 $\mu\text{g/mL}$. The increase in antioxidant activity is also associated with an increase in anthocyanins and vitamin E in soybean sprouts which act as antioxidant compounds (Asropah *et al.* 2019). The soybean germination process can also increase the vitamin E and vitamin C components in soybeans (Aminah 2020). Vitamin C helps prevent complications of type 2 diabetes mellitus by inhibiting sorbitol production. Meanwhile, vitamin E can improve the potential of the free radical defense system and has beneficial effects in improving glucose transport and insulin sensitivity (Hendriyani *et al.* 2018).

Fiber is a type of complex carbohydrate that is good for consumption by people with diabetes mellitus. High fiber foods can reduce blood glucose levels in the body by providing a longer feeling of satiety. Slower gastric emptying and digestion of food makes satiety longer so that food intake decreases. The decrease in food intake so that glucose absorption decreases make blood glucose levels lower/normal (Soviana & Maenasari 2019).

CONCLUSION

Soybean sprout juice demonstrated a significant hypoglycemic effect in this study, as evidenced by a blood glucose level of 77 g/dL at 60 minutes that further declined to 72 g/dL at 120 minutes following consumption, compared with soybean juice. This effect is likely mediated by the synergistic action of bioactive compounds present in soybean sprouts, including high-quality proteins, isoflavones, antioxidants, vitamins, and dietary fiber, which have been shown to enhance insulin sensitivity and attenuate postprandial glucose absorption. Collectively, these findings indicate that regular consumption of soybean sprout juice may serve as an effective adjunct nutritional strategy for glycemic control in individuals with type 2 diabetes mellitus.

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DECLARATION OF CONFLICT OF INTEREST

There is no conflict of interest in this study.

DECLARATION OF GENERATIVE AI IN SCIENTIFIC WRITING

The use of AI in translating formulas into narratives, large sampling formulas.

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