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Effect of Soydra pudding on fasting and postprandial blood glucose in Type 2 Diabetes Mellitus: A Laboratory-based study using the MEDICA EasyRA chemistry analyzer

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Abstract: The prevalence of type 2 diabetes mellitus (T2DM) continues to rise globally, particularly in developing countries. Despite its increasing burden, effective and affordable complementary treatments remain limited. Functional foods containing bioactive components such as soy and red dragon fruit have been shown to enhance insulin sensitivity and reduce oxidative stress. This study employed a randomized crossover design to evaluate the effect of Soydra pudding on blood glucose levels in patients with T2DM. Fasting blood glucose (FBG) and 2-hour postprandial blood glucose (2h-PBG) levels were measured before and after each intervention period using the MEDICA EasyRA Chemistry Analyzer. Each participant underwent both intervention and control (nutrition education) phases, each lasting 30 days, separated by a 15-day washout period to eliminate residual effects. Data were analyzed using paired t-tests with SPSS software. Compared to nutrition education, consumption of Soydra pudding significantly reduced FBG and 2h-PBG levels. The average reductions were 33.75 mg/dL for FBG ($p = 0.003$) and 51.66 mg/dL for 2h-PBG ($p < 0.001$). These findings suggest that Soydra pudding, rich in flavonoids and dietary fiber, can significantly improve glycemic control in patients with T2DM. The study supports the potential use of locally sourced functional foods as complementary dietary strategies in diabetes management.

Keywords: Type 2 Diabetes Mellitus; Functional Foods; Soydra Pudding; MEDICA EasyRA; Dietary Fiber.

INTRODUCTION

According to the World Health Organization (WHO), non-communicable diseases were the leading cause of death globally in 2018, accounting for 71% of all deaths. Among these, diabetes mellitus affects approximately 8.5% of the global adult population, with an estimated 422 million people worldwide diagnosed with the condition.[1] In Indonesia, the burden of non-communicable diseases continues to rise. The 2018 Basic Health Research (Riskesdas) reported that non-communicable diseases accounted for 69.91% of national disease incidence.[2] 2023 the prevalence of diabetes had reached 11.7%, and it is projected that by 2030, 21.3 million Indonesians will be living with diabetes mellitus.[3] In West Sumatra, the prevalence of diabetes increased from 1.3% in 2013 to 1.6% in 2018.[4] At Arosuka Regional Hospital, diabetes mellitus consistently ranks among the top ten most common outpatient diagnoses, with a rising number of cases each year.

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The high prevalence of diabetes mellitus is largely attributed to unbalanced dietary patterns, such as the frequent intake of high-sugar foods (>1×/day, 53.3%) and high fat foods (>1×/day, 40.7%), combined with low fiber intake. These factors contribute to obesity and elevated postprandial blood glucose levels. [5]Low fiber intake is directly associated with higher blood glucose concentrations. Persistent dietary imbalance can lead to poor glycemic control and increase the risk of complications including coronary heart disease, stroke, and kidney failure.[6]

Several functional foods have been proposed to support glycemic control, including soy milk and red dragon fruit (*Hylocereus polyrhizus*). Soy milk is rich in protein, fiber, lecithin, and isoflavones, compounds known to lower cholesterol, regulate glucose metabolism, and reduce insulin resistance. Isoflavones such as genistein have demonstrated hypoglycemic effects by enhancing insulin sensitivity and glucose tolerance. A soy intake of 25 g/day, equivalent to 37-62 mg/day of isoflavones, has been shown to fulfill 83% of daily isoflavone requirements.[7] Clinical studies have reported that 30 g/day of isolated soy protein with 132 mg of conjugated isoflavones over 12 weeks significantly reduced fasting insulin, insulin resistance, HbA1c, and LDL cholesterol levels.

Red dragon fruit is another functional food with antidiabetic properties. It contains antioxidants such as flavonoids, vitamin C, vitamin E, and potassium, which help reduce oxidative stress and improve insulin sensitivity. The flavonoid content in red dragon fruit is approximately 7.21 ± 0.02 mg CE/100 g, and the recommended daily flavonoid intake ranges from 50–80 mg. Other bioactive compounds present include betalains, polyphenols, and phenolic acids, which have been shown to boost antioxidant enzyme activity and protect pancreatic β-cells.[8] DM Management usually done with combination treatment and lifestyle. Until now, the drug has only been a food supplement. Only needs to be given when adjustment pattern Eat no longer can control blood sugar levels.[9]

Despite growing evidence supporting the role of dietary interventions in T2DM management, their application in clinical practice remains underutilized, especially when it comes to locally available functional foods. Most existing studies have used observational or small-scale designs without employing standardized laboratory analyzers.

Therefore, this study aims to investigate the effect of Soydra pudding a novel functional food made from soy milk and red dragon fruit on fasting and 2-hour postprandial blood glucose levels in patients with T2DM. The outcomes were measured using the MEDICA EasyRA clinical chemistry analyzer to ensure accuracy, objectivity, and clinical relevance in real-world outpatient settings.

MATERIAL AND METHOD

This study is a *randomized crossover trial* comparing two nutritional interventions, namely counseling and nutrition education regarding fasting blood glucose levels and postprandial blood glucose levels, and the administration of soydra pudding (soybeans and red dragon). The sampling in this study was conducted using purposive sampling techniques, involving 32 male respondents aged 40 to 60 years who have been diagnosed with uncomplicated Type 2 Diabetes Mellitus and are undergoing outpatient treatment at RSUD Arosuka, Solok, West Sumatra. Subjects who met the inclusion and exclusion criteria were invited to participate, after being provided with both verbal and written explanations regarding the purpose, procedures, benefits, and potential risks of the research. All respondents who are willing to participate in the study sign the informed consent form. This research has obtained ethical approval from the Health Research Ethics Committee of the Faculty of Medicine, Diponegoro University, with the number: 47/EC/FK-RSDK/2025.

This study used a washout period of 15 days. Given the bioactive content of dragon fruit and soybeans, which can have a long-lasting influence on blood glucose levels, a 15 day washout interval was used between the two interventions

to make sure there were no lingering effects from the prior therapy. This period alludes to common procedures used in comparable crossover studies to guarantee the reliability of the findings.

Inclusion criteria

Participants in this study were male outpatients aged between 40 and 60 years diagnosed with type 2 diabetes mellitus, receiving care at RSUD AroSuka. Eligible participants had fasting or random blood glucose levels exceeding 200 mg/dL but did not present with severe diabetes-related complications. All participants were alert, able to communicate effectively, and were undergoing treatment with oral hypoglycemic agents without reliance on insulin injections. Informed consent was obtained from each participant after a thorough explanation of the study procedures. Furthermore, participants were required to refrain from consuming any morning snacks other than the provided Soydra pudding (made from soybeans and red dragon fruit) for a period of 30 consecutive days. Only those who had previously received diabetes education were included in the study.

Exclusion criteria

Patients were excluded from the study if they were hospitalized with type 2 diabetes mellitus accompanied by severe complications, including kidney failure, heart failure, stroke, or severe hypertension, as diagnosed at RSUD AroSuka. Additionally, individuals who were unwilling to have their blood glucose levels measured or who had passed away during the study selection phase were excluded from participation.

Intervention procedure

The intervention provided in this study was SOYDRA pudding, a functional food product developed from a combination of soy milk and red dragon fruit. One serving of pudding weighing 150 grams contains 100 ml of soy milk, 50 ml of red dragon fruit extract, 10 grams of powdered agar-agar, 1.5 grams of stevia sugar, and 100 ml of boiled water. The administration was done twice a day, at 10:00 AM and 4:00 PM, with a total daily consumption of 300 grams, for 30 consecutive days. The pudding is served cold and delivered directly to the respondents' homes by the researchers to ensure compliance with consumption and prevent irregularities in the intervention.

Blood sampling procedure Venous blood samples were collected after an overnight fast, using plain vacutainers. Serum was separated by centrifugation at 3,000 rpm for 10 minutes. Glucose analysis Blood glucose levels were measured using the MEDICA EasyRA automated chemistry analyzer, employing the glucose oxidase-peroxidase enzymatic method. Daily calibration and internal quality control were performed in accordance with the manufacturer’s protocol.

RESULTS AND DISCUSSION

Table 1 delineates the baseline demographic and clinical attributes of the 32 people participating in the trial. A significant proportion of participants (68.7%) were aged between 51 and 60 years. All participants were male, in accordance with the inclusion criteria. A majority of responders (78.1%) were administered oral glucose-lowering medicines. Concerning nutritional status, 43.8% of individuals exhibited a normal BMI, whereas 28.1% were classified as underweight, and 28.1% were categorized as overweight or obese. Physical activity levels were evenly divided, with 34.4% categorized as participating in light exercise, 34.4% in vigorous activity, 18.8% in very light activity, and 12.5% in moderate activity. A marginal majority (56.3%) indicated an absence of familial diabetes history, whilst 43.8% acknowledged its presence. Significantly, 84.4% of individuals complied with dietary guidelines.

The participant profile reveals a predominantly uniform group regarding gender and age, consisting entirely of males, with the majority aged between 51 and 60 years. The significant percentage of persons utilizing glucose-lowering medication indicates a population currently receiving conventional diabetes

therapy, hence justifying the exploration of functional food as an adjunctive intervention. The majority exhibited good nutritional status; nevertheless, a notable proportion were either underweight or overweight, reflecting diversity in BMI across participants. Physical activity levels were varied, exhibiting a balance between mild and intense activity, potentially affecting glucose metabolism. The elevated level of dietary adherence is a strength of the study, mitigating any confounding from erratic eating behavior.

Table 1. Characteristics of Study Participants

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	43–50	10	31.3
	51–60	22	68.7
Sex	Male	32	100.0
Antidiabetic Medication Use	Yes	25	78.1
	No	7	21.9
Nutritional Status (BMI)	Underweight	9	28.1
	Normal	14	43.8
	Overweight	5	15.6
	Obese	4	12.5
Physical Activity Level	Very light	6	18.8
	Light	11	34.4
	Moderate	4	12.5
	Heavy	11	34.4
Family History of Diabetes	Yes	14	43.8
	No	18	56.2
Dietary Adherence	Adherent	27	84.4
	Non-adherent	5	15.6

Table 2 presents the mean values and standard deviations of fasting blood glucose (FBG) and 2-hour postprandial blood glucose (2h-PBG) levels before and after the 30-day intervention with Soydra pudding. Both parameters show a significant reduction following the intervention.

Table 2. Effect of Soydra Pudding on Fasting and 2-Hour Postprandial Blood Glucose Levels

Parameter	Before Intervention mg/dL (Mean ± SD)	After Intervention mg/dL (Mean ± SD)	p-value
Fasting Blood Glucose (FBG)	195.09 ± 40.57	134.59 ± 32.77	0.003
2-Hour Postprandial Blood Glucose (2h-PBG)	285.88 ± 40.15	211.13 ± 59.27	< 0.001

The findings indicate a statistically significant improvement in glycemic management following the intake of Soydra pudding. The average FBG level diminished by around 60.5 mg/dL (from 195.09 to 134.59 mg/dL, $p = 0.003$), whilst the 2h-PBG level exhibited a more substantial decline of approximately 74.8 mg/dL (from 285.88 to 211.13 mg/dL, $p < 0.001$). The findings indicate that regular intake of Soydra pudding, abundant in flavonoids and dietary fiber, may enhance insulin sensitivity and postprandial glucose management in individuals with type 2 diabetes mellitus.

Most of the respondents in this study were aged 51-60 years. Age is a major risk factor for type 2 diabetes mellitus because pancreatic function and insulin sensitivity decline with age.[10] That individuals over the age of 50 have a two-fold higher risk of developing insulin resistance compared to younger individuals. All respondents in this study were male. [11] Men have a higher risk of developing type 2 diabetes compared to women due to differences in body fat distribution and levels of sex hormones that affect glucose metabolism. A total of 78.1% of respondents in this study regularly consumed antidiabetic medication.11 The use of drugs like

metformin can increase insulin sensitivity and lower fasting blood glucose levels, making pharmacological therapy one of the main pillars in diabetes management.[12] The distribution of respondents' nutritional status shows that 43.8% have normal nutritional status, 28.1% are underweight, 15.6% are overweight, and 12.5% are obese. Obesity is a major risk factor for diabetes because it increases insulin resistance and systemic inflammation.[13]

A study by Bray et al. (2018) showed that individuals with a body mass index (BMI) above 30 kg/m² have a three times higher risk of developing diabetes compared to individuals with a normal BMI. A total of 34.4% of respondents reported light physical activity, while 18.8% were classified as very light. Physical activity plays an important role in reducing insulin resistance and improving glucose sensitivity (Colberg et al., 2016). Regular physical activity for 150 minutes per week can significantly lower HbA1c levels. As many as 50% of respondents have a family history of diabetes.[14] The percentage of those who are descendants is 60.6% (69 people), while for those who are not, it is 39.5% (45 people). The duration of diabetes mellitus depends on how well a person can control their blood sugar levels due to the disease.[15] The majority of respondents adhered to the DM diet, totalling 36 people (54.5%), while 30 respondents (45.5%) did not adhere to the DM diet.[16] Adherence to antidiabetic medication affects patients' blood sugar levels, therefore, adherence to antidiabetic medication can be a patient's choice in controlling their blood sugar. Metformin is the primary antidiabetic medication of choice for patients who are obese, have dyslipidaemia, and insulin resistance, as it functions to reduce insulin resistance and lower hepatic glucose production.

Table 2 showed a 30 day intervention in which Soydra pudding was administered twice daily, the treatment group's fasting blood glucose levels (FBG) and 2-hour postprandial blood glucose (2h-PBG) significantly decreased in comparison to the nutrition education group. A statistically significant and possibly clinically significant improvement in fasting glucose control is indicated by a drop of 33.75 mg/dL. A lower risk of long-term consequences such diabetic retinopathy, vascular endothelial dysfunction, and diabetic nephropathy is directly linked to lower fasting blood glucose levels.

The decrease of 51.66 mg/dL reflects better postprandial glucose control. This is important because postprandial hyperglycemia is a strong predictor of cardiovascular complications and microangiopathy damage. 2-hour postprandial blood glucose (2h-PBG) levels that remain high even when fasting blood glucose levels (FBG) improves are often associated with disease progression and insulin resistance. The decrease in fasting blood glucose levels (FBG) and 2-hour postprandial blood glucose (2h-PBG) reflects the clinical potential of the combination of isoflavones (from soybeans) and flavonoids (from red dragon fruit) in improving insulin sensitivity, slowing down glucose absorption in the intestines, and reducing oxidative stress. The high fiber content in the pudding also contributes to the glucose-lowering effect by slowing gastric emptying and glucose absorption. Thus, the intervention in the form of Soydra pudding consumption can be a promising functional diet strategy in supporting glycemic control in patients with type 2 diabetes mellitus, especially as an addition to standard nutritional education.

The decrease in fasting blood glucose (FBG) levels by 33.75 mg/dL and 2-hour postprandial blood glucose (2h-PBG) by 51.66 mg/dL after intervention with Soydra pudding demonstrates a significant clinical effect, especially when compared to the glycemic control targets according to the American Diabetes Association (ADA, 2024) and World Health Organization (WHO) guidelines. The FBG target according to the ADA is 80–130 mg/dL, and the 2h-PBG target is <180 mg/dL. With a decrease from 195.09 mg/dL to 134.59 mg/dL (FBG) and from 285.88 mg/dL to 211.13 mg/dL (2h-PBG), these results reflect significant effectiveness, although they have not fully reached the optimal clinical limits. This

decrease reduces the risk of microangiopathic complications such as diabetic nephropathy and retinopathy.[17]

Based on the meta-analysis by Poolsup et al. (2017), it was shown that the use of dragon fruit in T2DM patients did not significantly reduce FPG or 2h PPG (MD 26.5 mg/dL & MD 30.5 mg/dL, but with a wide confidence interval). The pooled results showed a significant reduction in FPG in favor of dragon fruit, with an MD of 15.1 mg/dL (95% CI: -23.8 to -6.5 mg/dL, P-value = 0.0006) (Heterogeneity: Chi 22 = 0.2, df = 2; I 2 = 0%, 95% CI: 0-62%). The effect remained unchanged when sensitivity analysis was performed using a random effects model (MD 15.1 mg/dL, 95% CI: -23.8 to -6.5 mg/dL, P-value = 0.0006). After administering red dragon fruit and red guava pudding (NAMBUIRA) to the treatment group, the highest blood glucose level was 368 mg/dL and the lowest blood glucose level was 116 mg/dL, with the average blood glucose level after treatment being 210.70 mg/dL.[18] In addition, soluble fiber in Soydra pudding (±6.25%) slows gastric emptying and glucose absorption in the small intestine. This mechanism reduces postprandial blood glucose spikes and improves daily glycemic control.[19]

Based on the results of a meta-analysis by Zhang et al. (2016), it was found that soy protein supplementation for ≥6 months reduced fasting plasma glucose by –0.207 mmol/L (37 mg/dL), and also significantly improved fasting insulin and HOMA-IR in patients with type 2 diabetes and metabolic syndrome.[20] A cross-over study by Diabetes Care (2002) also noted significant reductions in fasting insulin (8%), HOMA-IR (6.5%), and HbA1c (0.64%) after 12 weeks of soy isoflavone supplementation.[21] Based on the results of the latest meta-analysis, which did not always show significant reductions in glucose, some individual studies indicate clinical benefits of soy on glycemic control.[22]

Blood glucose levels can be controlled by chemical drugs and medicinal plants that effectively influence blood glucose concentration. Dragon fruit is one of the medicinal plants that has been reported to have potential as a treatment for diabetes mellitus.[23] Dragon fruit is a rich source of natural antioxidants including betacyanin, flavonoids, phenolic acids, ascorbic acid, and fiber. With its antioxidant and free radical scavenging activity, it has a preventive effect on the histopathological image of pancreatic β cells in alloxan-induced diabetic rats by reducing reactive oxygen species.[24] This blood glucose-lowering effect can be explained by the flavonoid and soluble fiber content in Soydra pudding. Flavonoids from red dragon fruit, such as anthocyanins and quercetin, are powerful antioxidants that play a role in reducing oxidative stress and improving insulin sensitivity, as well as protecting pancreatic β-cells from damage.[8]

This finding strengthens the mechanism observed in this study, namely the synergistic effect between soy protein/isoflavones and fiber from red dragon fruit in increasing insulin sensitivity and lowering blood glucose. The results of this study indicate that the administration of Soydra pudding for 30 days significantly reduced fasting blood glucose levels by 33.75 mg/dL (p = 0.003) and 2-hour postprandial blood glucose by 51.66 mg/dL (p = 0.000), reflecting the effectiveness of the intervention based on a combination of soybeans and red dragon fruit. This decrease is greater than the study by Setyani et al. (2019), who provided red dragon fruit milk pudding for 10 days and resulted in a 35 mg/dL decrease in fasting blood glucose but showed no significant difference between the intervention and control groups (p = 0.070). This difference in results indicates that the addition of active components such as isoflavones from soybeans in Soydra pudding can have a stronger glycemic impact compared to using only red dragon fruit.[25]

One of the main advantages of this study lies in the use of a standardized clinical biochemistry analysis tool, namely the MEDICA EasyRA Chemistry Analyzer, which employs the glucose oxidase-peroxidase (GOD–POD) method for measuring fasting blood glucose (FBG) and 2-hour postprandial glucose (2hPPG) levels. Unlike previous studies that generally used glucometers or small laboratory-scale instruments, the use of this instrument improves the accuracy, objectivity,

and reliability of measurement results. This is supported by the study by Kumar et al. (2019), which reported that the GOD–POD method showed a very high correlation with the hexokinase reference method (r ≈ 0.99) and produced analytical errors that remained below the Total Allowable Error (TEa) limit set in clinical laboratory standards.[26] Additionally, the research findings of Ayyanar et al. (2018) on 762 plasma samples showed that the GOD–POD method has a recovery rate of 88–100%, low coefficient of variation (<5%), and comparable performance to the reference method, making it valid for clinical blood glucose measurement. Therefore, the use of MEDICA EasyRA in this study not only improves data quality but also provides higher methodological strength compared to previous approaches.[27]

The Soydra pudding developed in this study contains flavonoids (0.0174 mgeq/Gr), level fiber (6.2513%), as well as carbohydrate Which relatively low (4.1973%). Flavonoids And fiber own role important in control level glucose blood through mechanisms such as increasing insulin sensitivity and slowing glucose absorption in the intestine. [28] Flavonoids, found in soybeans and red dragon fruit, have potent antioxidant effects that can reduce oxidative stress in people with diabetes. [29]Dietary fiber has also been shown to lower postprandial blood glucose levels by slowing carbohydrate digestion and absorption. [30]

According to research by Rachmad Aprilio (2024), the largest age group among respondents (41.7%) was 46-55 years. study show that more from half respondents various sex man (72.2%), and women (27.8%). [31] Obesity and body fat distribution In general, men develop type 2 diabetes at a younger age and at a lower BMI. [32] Michelle's research (2021), in this study, the majority of patient respondents were aged 40-60 years, namely 27 patients, while the remaining patients aged > 60 years were 13 patient. Age enter factor which cannot be modified but has a close correlation with type 2 DM, so that with know factor This, People who are at risk of suffering from type 2 diabetes can do this prevention like control of other factors that weaken in type 2 DM. The elderly age group is at 3 times higher risk affected DM type 2 compared to young because aging results in decreased insulin sensitivity and decreased function body For metabolism glucose. [33] According to Corazon's research (2023), compliance with taking antidiabetic medication affects blood sugar levels. patient, by Because That compliance drink drug Antidiabetics can be an option for patients to control their blood sugar. Metformin is the main antidiabetic drug of choice for patients with obesity, dyslipidemia, and insulin resistance, which functions to reduce insulin resistance and reduce hepatic glucose production. [34]

This study shows that consuming Soydra Pudding can be an effective alternative functional food in controlling blood glucose levels in people with type 2 diabetes mellitus. These results support previous studies indicating that the combination of soybeans and dragon fruit can have a positive effect on glycemic control and reduce the risk of diabetes complications.

This study has multiple limitations that warrant consideration. The limited sample size (n = 32) may restrict the applicability of the findings to a wider population. The trial lasted for 30 days, thus it cannot adequately illustrate the long-term effects of Soydra pudding consumption on chronic glucose management. Third, all subjects were male; hence, the findings of this study cannot yet be generalized to the female population, which may exhibit distinct metabolic reactions. Fourth, this study did not assess additional significant characteristics, such as glycated hemoglobin (HbA1c), which serves as an indicator of long-term glucose regulation. Moreover, factors such as fluctuations in physical activity, dietary intake outside the intervention, and comorbidities were not rigorously regulated, potentially serving as confounding variables.

CONCLUSION

The ingestion of Soydra pudding markedly decreased fasting and 2-hour postprandial blood glucose levels in individuals with type 2 diabetes mellitus. The results, derived from biochemical analysis via an automated chemistry analyzer, indicate that functional meals with bioactive constituents like flavonoids and dietary fiber may work as useful adjuncts to traditional glycemic control methods. This study emphasizes the possibility of Soydra pudding, made from locally sourced ingredients soy milk and red dragon fruit as a culturally relevant and accessible dietary intervention for diabetes management. Future research should investigate the long-term effects of Soydra pudding consumption on glycemic management and insulin sensitivity, as well as its influence on other biomarkers such as HbA1c and lipid profiles. Research with more heterogeneous populations, encompassing female participants, higher sample sizes, and varied age groups, is required to substantiate the generalizability of these findings. Moreover, randomized controlled trials with extended follow-up durations and multicenter frameworks could yield more robust evidence for the incorporation of these functional foods into standard diabetes management procedures.

AUTHORS' CONTRIBUTIONS

ZA, DNA, and AS contributed equally to the conception and design of the study, data collection, data analysis and interpretation, as well as drafting and revising the manuscript. All authors were actively involved in the preparation of this article, critically reviewed its content, and approved the final version for submission and publication. The authors declare that their contributions were equal throughout the research process.

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DATA AVAILABILITY STATEMENT

The utilized data to contribute to this investigation are available from the corresponding author on reasonable request.

DISCLOSURE STATEMENT

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors. The data is the result of the author's research and has never been published in other journals.

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