



Research Article

Effect of Flaxseed Supplementation on Glycemic Control in Newly Diagnosed Type 2 Diabetes Mellitus: A Controlled Interventional Study

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Abstract: Background: Type 2 diabetes mellitus is a chronic metabolic disorder characterized by hyperglycemia and insulin resistance. Dietary interventions are increasingly being explored as adjuncts to conventional diabetes management. Flaxseed (*Linum usitatissimum*), rich in dietary fiber, lignans, and omega-3 fatty acids, has shown potential benefits in improving glycemic control. The impact of flaxseed supplementation on glycaemic indices in patients with newly diagnosed non-insulin-dependent type 2 diabetes was assessed in this study. **Methods:** A controlled interventional study was conducted over one year at a specialty diabetes clinic in Pune, India. Sixty newly diagnosed T2DM (Type 2 Diabetes Mellitus) patients were divided into two groups: an experimental group (n = 30) receiving 20 g of flaxseed powder daily along with standard medical treatment and dietary advice, and a control group (n = 30) receiving only standard treatment and dietary advice. The intervention lasted 90 days. At baseline and at the conclusion of the trial, measurements of FBS (Fasting Blood Sugar), PPBS (Postprandial Blood Sugar), HbA1c, and BMI (Body Mass Index) were taken. SPSS software was used for statistical analysis, and p<0.05 was deemed significant. **Results:** After 3 months, the experimental group demonstrated a statistically significant reduction in FBS, PPBS, and HbA1c levels compared with the control group (p<0.001). A significant improvement in BMI was also observed in the flaxseed-supplemented group. These findings indicate that flaxseed supplementation enhanced both short-term and long-term glycemic control in newly diagnosed T2DM patients. **Conclusion:** Daily supplementation with 20 g flaxseed powder for 90 days significantly improved glycemic control and reduced BMI in newly diagnosed, non-insulin-dependent T2DM patients. Flaxseed may serve as a safe, cost-effective, and nutritionally beneficial adjunct to conventional diabetes management. Further large-scale and long-term studies are recommended to confirm these findings.

Keywords: Flaxseed, Type 2 Diabetes Mellitus, Glycemic Control, Fasting Blood Sugar, Postprandial Blood Sugar, HbA1c, Dietary Intervention, BMI

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INTRODUCTION

A rapidly expanding global health concern, T2DM (Type 2 Diabetes Mellitus) is characterised by increasing pancreatic β -cell failure and chronic hyperglycemia brought on by insulin resistance [1]. The global burden of T2DM continues to increase, making early diagnosis and effective management essential for preventing long-term microvascular and macrovascular complications [2].

Medical nutrition therapy is considered a cornerstone of diabetes management alongside pharmacological treatment. Growing attention has been directed toward functional foods that may improve glycemic control through naturally occurring bioactive compounds. Flaxseed (*Linum usitatissimum*) has emerged as one such functional food because it contains high amounts of soluble and insoluble dietary fiber, alpha-linolenic acid (ALA), lignans, and phenolic compounds that may improve insulin sensitivity, delay glucose absorption, and reduce systemic inflammation [3-4].

Evidence from randomized controlled trials suggests that flaxseed supplementation has beneficial effects on glycemic control in individuals with prediabetes and T2DM. Significant reductions in fasting blood glucose, fasting insulin levels, and insulin resistance measured by the HOMA-IR (Homeostatic Model Assessment for Insulin Resistance) have been reported following whole flaxseed supplementation, particularly when administered for at least 12 weeks [2]. Improvements in glycated HbA1c (Haemoglobin), fasting blood glucose, insulin concentration, and insulin sensitivity have also been demonstrated, supporting the role of flaxseed as a potential dietary adjunct in diabetes management [1].

More recent evidence has strengthened these observations, with pooled analyses showing significant improvements in fasting blood glucose, fasting insulin, HOMA-IR, and insulin sensitivity across multiple randomized controlled trials [4]. Whole flaxseed appears to produce greater metabolic benefits than flaxseed oil or isolated lignan preparations, suggesting that the combined action of its fibre and bioactive constituents contributes to its therapeutic effect [4].

Furthermore, significant reductions in HbA1c have been observed among individuals with T2DM, particularly in those with poorer baseline glycemic control [3].

Imms and Objectives

This study aimed to assess the impact of flaxseed supplementation on glycaemic management in newly diagnosed individuals with type 2 diabetes mellitus. Specifically, the study sought to assess the nutritional profile of flaxseed and determine its efficacy in reducing blood glucose levels among newly diagnosed, non-insulin-dependent type 2 diabetic patients following dietary supplementation.

MATERIALS AND METHODS

Study Design

This controlled interventional study was conducted over a period of one year, from 1 November 2022 to 30 October 2023, at the OPD (Outpatient Department) of Ayur DiabaPro Diabetes Clinic, a specialty diabetes clinic in Pune, Maharashtra.

Inclusion and Exclusion Criteria

Male and female patients between the ages of 30 and 45 who had recently been diagnosed with non-insulin-dependent T2DM, had no significant diabetic complications, and were on therapy with OHAs (Oral Antihyperglycemic Drugs) were included in the study. Patients with type 1 diabetes, gestational diabetes, MODY (Maturity-Onset Diabetes of the Young), LADA (Latent Autoimmune Diabetes in Adults), pregnancy or lactation, or children were not allowed to participate. Individuals receiving insulin therapy, those with a history of cancer, myocardial infarction, stroke, or drug/alcohol abuse, as well as patients with renal, cardiac, hepatic, gastrointestinal, thyroid, mental health, or nutritional disorders, and those with known allergies or intolerances to flaxseed were also excluded to minimize potential confounding factors and ensure the safety of the intervention.

Data Collection Procedure

Data were collected from 60 newly diagnosed type 2 diabetes mellitus patients attending the outpatient department after obtaining written informed consent. Baseline information, including age, occupation, marital status, dietary habits, duration of diabetes, medication history, and clinical symptoms, was recorded using a structured case record form. Participants were allocated into a control group (n = 30) and an experimental group (n = 30), with the experimental group receiving 20 g of roasted flaxseed powder daily for 90 days. Both groups received standardized dietary advice (1800±200 kcal/day) and were encouraged to perform 30–60 minutes of daily physical activity. Anthropometric measurements (height, weight, and BMI) and biochemical parameters, including FBS (Fasting Blood Sugar), PPBS (Post-Prandial Blood Sugar), and HbA1c (HPLC method), were assessed at baseline (Day 0). Flaxseed powder was distributed weekly in zip-lock bags to monitor participant compliance, and four participants from the experimental group were excluded due to dropout during the study period.

Statistical Analysis

The SPSS (Statistical Package for the Social Sciences) version 10.0 (SPSS Inc., Chicago, IL, USA) was used to analyse the data after they were entered into Microsoft Excel. The mean±standard deviation (SD) was used to express continuous variables. Group comparability was evaluated by comparing the baseline characteristics of the experimental and control groups. Each group's pre- and post-intervention values were compared using a paired Student's t-test, and the mean changes between the experimental and control groups were compared using an independent Student's t-test. According to the null hypothesis, there was no discernible difference between the two groups' anthropometric and glycaemic characteristics. A two-tailed approach was used for all statistical tests, and a p-value of less than 0.05 was deemed statistically significant.

RESULTS

Table 1 illustrates the intergroup comparison of mean age between the experimental and control groups. The experimental group had a mean age of 35.93 years (SD 3.77), compared with 36.63 years (SD 3.97) in the control group. An unpaired t-test yielded $t = -0.699$ and $p = 0.487$, indicating no statistically significant difference in age between the two groups, confirming that the groups were comparable at baseline with respect to age.

Table 1: Comparison of Mean Age Distribution between the Experimental and Control Groups

Group	Mean (yrs)	SD	Unpaired t-test	p-value
Experimental Group	35.93	3.77	$t = -0.699$	$p = 0.487$
Control Group	36.63	3.97		

Table 2: Comparison of Gender Distribution between the Experimental and Control Groups

Group	Male n (%)	Female n (%)	Chi-square	p-value
Experimental Group	24 (80%)	6 (20%)	0.8	0.371 (NS)
Control Group	21 (70%)	9 (30%)		

Table 3: Comparison of Food Habits between the Experimental and Control Groups

Group	Vegetarian n (%)	Non-Vegetarian n (%)	Chi-square	p-value
Experimental Group	6 (20%)	24 (80%)	3.7	0.052 (NS)
Control Group	13 (43.3%)	17 (56.7%)		

Table 4: Intergroup Comparison of Body Mass Index (BMI) at Baseline, 3 Months, and Change from Baseline

Parameter	Experimental Group Mean (SD)	Control Group Mean (SD)	Unpaired t-test	p-value, Significance
Baseline	28.55 (4.16)	26.44 (3.16)	t = 2.203	p = 0.051 (NS)
3 Months	27.57 (4.08)	26.26 (3.13)	t = 1.4	p = 0.065 (NS)
Change (Baseline - 3 Months)	0.97 (0.48)	0.18 (0.18)	t = 3.98	p = 0.031*

Table 5: Intergroup Comparison of Fasting Blood Sugar Level (BSL-F) at Baseline, 3 Months, and Change from Baseline

Parameter	Experimental Group Mean (SD)	Control Group Mean (SD)	Unpaired t-test	p-value, Significance
Baseline	208.57 (50.84)	188.5 (46.06)	t = 1.602	p = 0.115 (NS)
3 Months	116.5 (16.34)	132.53 (33.06)	t = -2.381	p = 0.021*
Change (Baseline - 3 Months)	92.06 (41.85)	55.96 (30.57)	t = 3.815	p < 0.001***

Table 6: Intergroup Comparison of Post-Prandial Blood Sugar Level (BSL-PP) at Baseline, 3 Months, and Change from Baseline

Parameter	Experimental Group Mean (SD)	Control Group Mean (SD)	Unpaired t-test	p-value, Significance
Baseline	285.27 (80.79)	271.67 (69.05)	t = 0.701	p = 0.486 (NS)
3 Months	152.63 (34.81)	190.17 (60.33)	t = -2.951	p = 0.005**
Change (Baseline - 3 Months)	132.63 (58.22)	81.5 (44.74)	t = 3.814	p < 0.001***

The distribution of male and female participants in the two groups is shown in Table 2. There were 21 males (70%) and 9 females (30%) in the control group, compared to 24 males (80%) and 6 females (20%) in the experimental group. The gender distribution between the groups did not differ statistically significantly, according to a chi-square test ($\chi^2 = 0.8$, $p = 0.371$), indicating that gender was not likely to have influenced the glycaemic results listed below.

Table 3 depicts the dietary pattern of participants in both groups, as food habits can influence glycemic response to a fibre-rich supplement such as flaxseed. In the experimental group, 20% ($n = 6$) followed a vegetarian diet and 80% ($n = 24$) followed a non-vegetarian diet; in the control group, 43.3% ($n = 13$) were vegetarian and 56.7% ($n = 17$) were non-vegetarian. The chi-square test approached but did not reach statistical significance ($\chi^2 = 3.7$, $p = 0.052$), indicating only a trend toward a difference in food habits between the groups, which was not significant at the conventional threshold.

Table 4 presents the change in Body Mass Index (BMI) across the study period. At baseline, mean BMI was 28.55 (SD 4.16) in the experimental group and 26.44 (SD 3.16) in the control group ($t = 2.203$, $p = 0.051$), a marginal difference between groups. After 3 months, BMI declined to 27.57 (SD 4.08) in the experimental group and 26.26 (SD 3.13) in the control group ($t = 1.4$, $p = 0.065$), a non-significant difference. However, the mean reduction in BMI from baseline to 3 months was significantly greater in the experimental group (0.97 ± 0.48) than in the control group (0.18 ± 0.18) ($t = 3.98$, $p = 0.031$), indicating that flaxseed supplementation was associated with a significantly greater reduction in BMI over the study period.

Table 5 shows the intergroup comparison of BSL-F (Fasting Blood Sugar Level). At baseline, mean BSL-F was 208.57 mg/dL (SD 50.84) in the experimental group and 188.5 mg/dL (SD 46.06) in the control group, with no significant difference between groups ($t = 1.602$, $p = 0.115$). After 3 months, BSL-F decreased to 116.5 mg/dL (SD 16.34) in the experimental group but rose to 132.53 mg/dL (SD 33.06) in the control group, a statistically significant difference ($t = -2.381$, $p = 0.021$). The mean reduction in BSL-F from baseline to 3 months was 92.06 mg/dL (SD 41.85) in the experimental group versus 55.96 mg/dL (SD 30.57) in the control group ($t = 3.815$, $p < 0.001$), demonstrating a highly significant, greater fasting glucose-lowering effect with flaxseed supplementation.

Table 6 summarizes the intergroup comparison of BSL-PP (Post-Prandial Blood Sugar Level). At baseline, mean BSL-PP was 285.27 mg/dL (SD 80.79) in the experimental group and 271.67 mg/dL (SD 69.05) in the control group, with no significant difference ($t = 0.701$, $p = 0.486$). After 3 months, BSL-PP fell to 152.63 mg/dL (SD 34.81) in the experimental group compared with 190.17 mg/dL (SD 60.33) in the control group, a statistically significant difference ($t = -2.951$, $p = 0.005$). The reduction from baseline to 3 months was 132.63 mg/dL (SD 58.22) in the experimental group versus 81.5 mg/dL (SD 44.74) in the control group ($t = 3.814$, $p < 0.001$), confirming a highly significant, greater post-prandial glucose-lowering effect in the flaxseed-supplemented group.

Table 7: Intergroup Comparison of HbA1c Levels at Baseline, 3 Months, and Change from Baseline

Parameter	Experimental Group Mean (SD)	Control Group Mean (SD)	Unpaired t-test	p-value, Significance
Baseline	10.1 (2.15)	8.9 (1.67)	t = 2.411	p = 0.019*
3 Months	6.92 (1.12)	8.08 (1.33)	t = -3.620	p = 0.001*
Change (Baseline - 3 Months)	3.17 (1.67)	0.82 (0.49)	t = 7.387	p<0.001***

Table 7 reveals the intergroup comparison of HbA1c levels, the primary marker of long-term glycemic control. At baseline, mean HbA1c was 10.1% (SD 2.15) in the experimental group and 8.9% (SD 1.67) in the control group, a statistically significant difference (t = 2.411, p = 0.019). After 3 months, HbA1c declined to 6.92% (SD 1.12) in the experimental group while the control group declined only to 8.08% (SD 1.33), a significant intergroup difference (t = -3.620, p = 0.001). The mean reduction in HbA1c from baseline to 3 months was 3.17% (SD 1.67) in the experimental group compared with 0.82% (SD 0.49) in the control group (t = 7.387, p<0.001), demonstrating a highly significant improvement in glycemic control with flaxseed supplementation.

DISCUSSION

The present study evaluated the effect of 20 g/day flaxseed supplementation for 90 days on glycemic control among newly diagnosed T2DM patients receiving oral antihyperglycemic therapy. The findings demonstrated that flaxseed supplementation produced significant improvements in FBS, PPBS, HbA1c, and BMI compared with the control group. These findings support the potential role of flaxseed as an effective and affordable dietary adjunct for improving glycemic control in newly diagnosed T2DM patients.

Baseline Characteristics

The experimental and control groups were similar in terms of age and gender, according to the baseline data. There was no statistically significant difference between the experimental group's mean age of 35.93±3.77 years and the control group's mean age of 36.63±3.97 years (p = 0.487). Similarly, gender distribution did not differ significantly between groups (p = 0.371), although males constituted a larger proportion of participants in both groups. The absence of significant differences in these baseline variables reduces the possibility that demographic factors influenced the observed treatment effects.

These findings are comparable with those reported by Gunde *et al.*, who observed that the prevalence of diabetes varies across age groups in developing and developed countries, with younger adults increasingly being affected in developing regions [5]. Likewise, Delaney *et al.* reported that type 2 diabetes mellitus affects males and females differently, with a higher prevalence among males during middle age, which corresponds with the male predominance observed in the present study [6].

Food Habits

Food habits showed a borderline difference between groups (p = 0.052), with a greater proportion of vegetarian participants in the control group. However, this difference was not statistically significant and therefore is unlikely to have substantially influenced the primary outcomes.

Previous studies have demonstrated that diets rich in fruits, vegetables, whole grains, nuts, and seeds improve insulin sensitivity and contribute to better diabetes management [7]. Malik *et al.* highlighted the importance of dietary lipids and fiber-rich foods in improving metabolic health [7]. Since both groups received similar dietary counselling, the greater improvements observed in the experimental group are more likely attributable to flaxseed supplementation rather than dietary habit alone.

Effect on Body Mass Index

An important finding of the present study was the significant reduction in BMI following flaxseed supplementation. Although baseline BMI was marginally higher in the experimental group (28.55±4.16 kg/m²) than in the control group (26.44±3.16 kg/m²; p = 0.051), the reduction after 90 days was significantly greater in the experimental group (0.97±0.48 kg/m²) than in the control group (0.18±0.18 kg/m²; p = 0.031).

These findings agree with Gunde A. [5], who reported significant reductions in body weight and BMI following supplementation with 30 g/day flaxseed powder for two months [5]. In that study, body weight decreased from 80.24 kg to 79.08 kg, while BMI declined from 28.4 kg/m² to 28.0 kg/m², demonstrating the beneficial effects of flaxseed on anthropometric parameters. Furthermore, reductions in systolic and diastolic blood pressure were also observed, suggesting broader metabolic benefits.

However, Shareghfarid *et al.* (2022) reported no significant baseline differences in BMI or age between intervention groups, indicating that anthropometric responses to flaxseed supplementation may vary depending on study population and intervention characteristics [8].

The reduction in BMI observed in the present study may be explained by the high soluble fiber content of flaxseed, which delays gastric emptying, increases satiety, and reduces overall energy intake, thereby contributing to weight reduction and improved metabolic regulation.

Effect on Fasting Blood Sugar

The greatest clinical benefit of flaxseed supplementation was observed in fasting blood sugar levels. At baseline, FBS did not differ significantly between groups (208.57 ± 50.84 mg/dL vs. 188.50 ± 46.06 mg/dL; $p = 0.115$). After 90 days, however, the experimental group achieved a significantly lower FBS (116.50 ± 16.34 mg/dL) than the control group (132.53 ± 33.06 mg/dL; $p = 0.021$). More importantly, the reduction from baseline was substantially greater in the experimental group (92.06 ± 41.85 mg/dL) than in the control group (55.96 ± 30.57 mg/dL; $p < 0.001$).

These findings are consistent with previous clinical evidence. Gunde A. (2021) reported that flaxseed supplementation reduced fasting blood glucose from 157.7 mg/dL to 124.7 mg/dL, whereas no significant improvement occurred in the control group [5]. Similarly, Soltanian and Janghorbani (2018, 2019) demonstrated that regular flaxseed consumption over several weeks improved fasting glucose and other metabolic parameters in patients with type 2 diabetes [9].

The glucose-lowering effect of flaxseed is biologically plausible because its soluble fiber slows intestinal glucose absorption, while lignans and alpha-linolenic acid may improve insulin sensitivity and reduce inflammation.

Effect on Post-Prandial Blood Sugar

Post-prandial glucose regulation showed similar improvements. Baseline PPBS was comparable between groups (285.27 ± 80.79 mg/dL vs. 271.67 ± 69.05 mg/dL; $p = 0.486$). After supplementation, PPBS decreased to 152.63 ± 34.81 mg/dL in the experimental group compared with 190.17 ± 60.33 mg/dL in the control group ($p = 0.005$). The mean reduction was significantly greater in the experimental group (132.63 ± 58.22 mg/dL) than in the control group (81.50 ± 44.74 mg/dL; $p < 0.001$).

These results agree with Vuksan *et al.* [10], who demonstrated that flaxseed significantly reduced the post-prandial glycemic response following a glucose challenge [10]. Likewise, Almeahmadi *et al.* [11] reported that dividing flaxseed intake throughout the day produced sustained reductions in blood glucose over a 24-hour period [11].

The consistency of these findings strengthens the evidence that flaxseed is particularly effective in attenuating post-prandial glucose excursions, which are important predictors of long-term diabetic complications.

Effect on HbA1c

HbA1c represents the most reliable indicator of long-term glycemic control, and the present study demonstrated substantial improvement following flaxseed supplementation. Unlike the other baseline parameters, HbA1c was significantly higher in the experimental group ($10.10 \pm 2.15\%$) than in the control group ($8.90 \pm 1.67\%$; $p = 0.019$). Despite beginning with poorer glycemic control, the experimental group experienced a remarkable reduction to $6.92 \pm 1.12\%$ after 90 days, whereas the control group reached only $8.08 \pm 1.33\%$ ($p = 0.001$). The overall reduction was $3.17 \pm 1.67\%$ compared with only $0.82 \pm 0.49\%$ in the control group ($p < 0.001$).

These findings support the recommendations of the American Diabetes Association [12], which emphasizes achieving sustained HbA1c reduction through comprehensive diabetes management [12]. Comparable results were reported by Moreira *et al.* [13], who demonstrated that flaxseed incorporated into balanced meals significantly improved post-prandial glycemic control under standardized clinical conditions [13].

The marked reduction in HbA1c observed in the present study suggests that flaxseed supplementation not only improves short-term glucose regulation but also contributes to sustained improvements in overall glycemic control, making it a valuable adjunct to conventional diabetes therapy.

Limitation

The study's rather small sample size restricts how far the results may be applied.

CONCLUSION

As demonstrated by decreases in fasting blood glucose, HbA1c, and BMI, this controlled interventional trial shows that flaxseed supplementation, when taken as an addition to standard therapy, significantly improves glycaemic control in newly diagnosed type 2 diabetes Mellitus patients. These results imply that flaxseed could be a useful and affordable dietary intervention for the early control of type 2 diabetes. To validate these findings and gain a better understanding of the long-term impacts of flaxseed supplementation on metabolic health, further extensive and long-term research is necessary.

REFERENCES

1. Villarreal-Renteria, A. I. *et al.* "Effect of Flaxseed (*Linum usitatissimum*) Supplementation on Glycemic Control and Insulin Resistance in Prediabetes and Type 2 Diabetes: A Systematic Review and Meta-Analysis of Randomized Controlled Trials." *Complementary Therapies in Medicine*, vol. 70, 2022, article 102852.
2. Mohammadi-Sartang, M. *et al.* "Flaxseed Supplementation on Glucose Control and Insulin Sensitivity: A Systematic Review and Meta-Analysis of Randomized Placebo-Controlled Trials." *Nutrition Reviews*, vol. 76, no. 2, 2018, pp. 125–139.
3. Xi, H. *et al.* "Flaxseed Supplementation Significantly Reduces Hemoglobin A1c in Patients with Type 2 Diabetes Mellitus: A Systematic Review and Meta-Analysis." *Nutrition Research*, vol. 110, 2023, pp. 23–32.
4. Kavyani, Z. *et al.* "The Effect of Flaxseed Supplementation on Glycemic Control in Adults: An Updated Systematic Review and Meta-Analysis of Randomized Controlled Trials." *Journal of Functional Foods*, vol. 110, 2023, article 105816.
5. Gunde, A. "A Study to Assess the Effectiveness of Flaxseed Powder Supplementation on Blood Glucose Profile of Diabetic Individuals." *International Journal of Multidisciplinary Educational Research*, vol. 6, no. 10, 2021, pp. 13–19.
6. Delaney, K. Z., and S. Santosa. "Sex Differences in Regional Adipose Tissue Depots Pose Different Threats for the Development of Type 2 Diabetes in Males and Females." *Obesity Reviews*, vol. 23, no. 3, 2022, article e13393.
7. Malik, D. *et al.* "Dietary Lipids and Health." *Textbook of Nutritional Biochemistry*, Springer Nature Singapore, 2023, pp. 193–228.
8. Shareghfarid, E. *et al.* "The Effect of Flaxseed Oil Supplementation on Body Composition and Inflammation Indices in Overweight Adults with Pre-Diabetes." *Nutrition and Metabolic Insights*, vol. 15, 2022, article 11786388221090083.
9. Soltanian, N., and M. Janghorbani. "Effect of Flaxseed or Psyllium vs. Placebo on Management of Constipation, Weight, Glycemia, and Lipids: A Randomized Trial in Constipated Patients with Type 2 Diabetes." *Clinical Nutrition ESPEN*, vol. 29, 2019, pp. 41–48.
10. Vuksan, V. *et al.* "Comparison of Flax (*Linum usitatissimum*) and Salba-Chia (*Salvia hispanica* L.) Seeds on Postprandial Glycemia and Satiety in Healthy Individuals: A Randomized, Controlled, Crossover Study." *European Journal of Clinical Nutrition*, vol. 71, 2017, pp. 234–238.
11. Almeshmadi, A. *et al.* "The Effect of a Split Portion of Flaxseed on 24-h Blood Glucose Response." *European Journal of Nutrition*, vol. 60, 2021, pp. 1363–1373.
12. American Diabetes Association. "Glycemic Targets: Standards of Medical Care in Diabetes." *Diabetes Care*, vol. 42, 2019, pp. S61–S70.
13. Moreira, F. D. *et al.* "Acute Flaxseed Intake Reduces Postprandial Glycemia in Subjects with Type 2 Diabetes: A Randomized Crossover Clinical Trial." *Nutrients*, vol. 14, no. 18, 2022, article 3736.