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Effect of Fenugreek Seed Supplementation on Fasting and Postprandial Glucose in Type 2 Diabetes Mellitus: A Single-Group Pre–Post Study

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ABSTRACT: Background: Type 2 diabetes mellitus (T2DM) is a growing public-health challenge in India, and there is sustained interest in low-cost dietary adjuncts to conventional pharmacotherapy. Fenugreek (*Trigonella foenum-graecum*), known locally as methi or vendhayam, is a culinary staple in South India whose soluble fibre and bioactive constituents have plausible glucose-lowering activity. Objective: To estimate the pre–post change in fasting blood glucose (FBG), postprandial blood glucose (PPBG) and glycated haemoglobin (HbA1c) following 12 weeks of adjunctive fenugreek seed supplementation in adults with T2DM. Methods: In this single-group (single-arm) pre–post interventional study conducted at a tertiary care teaching hospital in South India, 60 adults (aged 35–70 years) with established T2DM on stable oral antidiabetic therapy received fenugreek seed powder 10 g/day in two divided doses for 12 weeks as an adjunct to their existing regimen. FBG, PPBG, HbA1c, weight and body mass index (BMI) were measured before and after the intervention. Paired *t*-tests, 95% confidence intervals (CI) and Cohen's d_z effect sizes were computed. Results: All 60 participants completed the study (mean adherence 90.6%). FBG fell from 160.42 (SD 25.59) to 135.87 (SD 27.42) mg/dL (mean change −24.55

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mg/dL; 95% CI −26.65 to −22.46; p<0.001; d_z=−3.03). PPBG fell from 234.33 (SD 34.61) to 197.25 (SD 35.28) mg/dL (mean change −37.08 mg/dL; 95% CI −40.17 to −33.99; p<0.001; d_z=−3.10). HbA1c fell from 8.12 (SD 0.73) to 7.54 (SD 0.76) % (mean change −0.59 percentage points; 95% CI −0.63 to −0.54; p<0.001; d_z=−3.32). Weight and BMI decreased modestly (−1.40 kg; −0.51 kg/m²). Only mild adverse effects occurred (8/60, 13.3%). Conclusion: Twelve weeks of adjunctive fenugreek 10 g/day was associated with clinically and statistically significant reductions in FBG, PPBG and HbA1c, with good tolerability, in this South Indian sample. Because the single-arm design has no control group, these associations cannot be attributed to fenugreek alone.

1. INTRODUCTION

Type 2 diabetes mellitus (T2DM) has emerged as one of the most pressing non-communicable disease challenges in India. The country carries one of the largest absolute burdens of diabetes worldwide, and epidemiological surveys have documented a steep rise in prevalence across both urban and rural populations, including throughout South India. This growing burden is driven by rapid nutritional transition, urbanization, sedentary lifestyles and a genetic predisposition to insulin resistance and early beta-cell dysfunction among South Asians. Sustained hyperglycemia, and in particular elevated postprandial glucose excursions, contributes to the development of microvascular and microvascular complications that impose substantial morbidity, premature mortality and out-of-pocket expenditure on patients and health systems alike.

Despite the availability of an expanding armamentarium of oral antidiabetic agents, a large proportion of patients in routine clinical practice do not achieve recommended glycemic targets. Barriers include cost, polypharmacy, adverse effects, therapeutic inertia and suboptimal adherence. In this context, there is longstanding and renewed interest in affordable, culturally acceptable, food-based adjuncts that might complement conventional pharmacotherapy and support glycemic control [1-3]. Herbal and functional-food approaches are especially attractive in resource-constrained settings and in populations with strong traditional dietary practices, provided their efficacy and safety are evaluated with appropriate scientific rigor [4,5].

Fenugreek (*Trigonella foenum-graecum*), known in South India as methi or vendhayam, is a leguminous herb whose seeds are a ubiquitous culinary and traditional-medicine ingredient. Fenugreek seeds are unusually rich in soluble fibre, principally galactomannan, which increases the viscosity of gut contents, slows gastric emptying and delays the absorption of glucose, thereby blunting postprandial glycaemia [6,7]. Beyond its fibre content, fenugreek contains several candidate bioactive constituents. The unusual amino acid 4-hydroxyisoleucine has been reported to stimulate glucose-dependent insulin secretion and to improve peripheral insulin sensitivity. The alkaloid trigonelline may influence glucose metabolism and beta-cell function, while steroidal sapiens and the saprogenic dysgenic have been linked to favorable metabolic and vascular effects in experimental models [8]. Dysgenic and related fenugreek constituents have additionally been associated with protection against diabetic complications in animal studies, including lens and renal pathology, suggesting mechanisms that extend beyond simple glucose lowering [9].

Individual randomized trials have compared fenugreek with, or added it to, standard therapy and reported reductions in fasting glucose and HbA1c [10,11]. Nevertheless, the evidence base remains heterogeneous with respect to dose, preparation, duration and population, and there is a particular scarcity of pragmatic data from South Indian clinical settings where fenugreek is already part of the habitual diet. Pragmatic evaluations embedded in routine care can help characterize the magnitude of glycemic change that might realistically accompany supplementation, and can generate hypotheses for definitive trials.

Against this background, we conducted a single-group pre–post study to estimate the change in FBG, PPBG and HbA1c, together with weight, BMI, adherence and tolerability, following 12 weeks of adjunctive fenugreek seed powder (10 g/day) in adults with T2DM on stable oral antidiabetic therapy in a tertiary care teaching hospital in South India. We explicitly frame the study as hypothesis-generating: the objective is to quantify within-participant change, not to establish causal efficacy.

2. MATERIALS AND METHODS

2.1 Study design and setting

This was a single-group (single-arm) pre–post interventional study, without a concurrent control group, conducted in the Department of General Medicine/Endocrinology of name of tertiary care teaching hospital, in South India. The reporting follows standard conventions for before–after intervention studies.

2.2 Ethical considerations

The study protocol was approved by the Institutional Ethics Committee ([IEC approval number and date]). Written informed consent was obtained from every participant before enrolment, in accordance with the principles of the Declaration of Helsinki. Where applicable, the study was registered prospectively.

2.3 Participants

Adults aged 35–70 years with established T2DM on stable oral antidiabetic therapy were eligible. Inclusion criteria were a documented diagnosis of T2DM and an unchanged oral antidiabetic regimen for at least the preceding three months. Exclusion criteria were pregnancy or lactation, treatment with insulin, major hepatic or renal disease, a recent change in antidiabetic medication, and known allergy to fenugreek. A demonstration sample of 60 participants was used, which allows stable descriptive estimates and adequately powered paired within-participant comparisons for the large effect sizes anticipated.

2.4 Intervention

Participants received fenugreek (*Trigonella foenum-graecum*) seed powder at a dose of 10 g/day, taken in two divided doses (5 g before the two main meals), for 12 weeks. Fenugreek was administered as an adjunct to each participant's existing, unchanged oral antidiabetic therapy; no attempt was made to alter background pharmacotherapy during the study period. Participants were advised to maintain their usual diet and physical-activity patterns.

2.5 Outcomes and measurements

The primary outcomes were fasting blood glucose (FBG) and 2-hour postprandial blood glucose (PPBG), both measured in mg/dL. Secondary outcomes were glycated hemoglobin (HbA1c, %), body weight (kg) and body mass index (BMI, kg/m²). All outcomes were assessed at baseline (pre) and at the end of the 12-week intervention (post) using standard laboratory and anthropometric methods. Adherence was monitored throughout (expressed as the percentage of prescribed doses taken), and adverse effects were recorded by structured enquiry at each visit, with attention to gastrointestinal symptoms and any hepatic or renal safety signals.

2.6 Statistical analysis

Continuous variables are summarized as mean and standard deviation (SD). For each outcome, the pre–post change was analyzed using the paired *t*-test, with the mean difference (post minus pre) and its 95% confidence interval (CI). The standardized within-participant effect size was quantified using Cohen's d_z, interpreted conventionally (approximately 0.2 small, 0.5 medium, 0.8 large). A two-sided p-value below 0.05 was considered statistically significant. Analyses were performed on all 60 participants who completed the study.

3. RESULTS

3.1 Baseline characteristics

Sixty adults with T2DM were enrolled, and all 60 (100%) completed the 12-week intervention. The mean age was 51.5 years (SD 11.1), with 33 men (55.0%) and 27 women (45.0%). The mean known duration of diabetes was 8.0 years (SD 4.3). Background antidiabetic therapy comprised metformin plus a DPP-4 inhibitor in 25 participants (41.7%), metformin plus a sulfonylurea in 18 (30.0%) and metformin alone in 17 (28.3%). Mean adherence to the fenugreek regimen was high at 90.6% (SD 5.0). Baseline characteristics are summarized in Table 1.

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Table 1. Baseline characteristics of participants (N=60).

Characteristic	Value
Sample size	60 participants
Mean age, years (SD)	51.5 (11.1)
Sex, Male / Female, n (%)	33 (55.0) / 27 (45.0)
Mean diabetes duration, years (SD)	8.0 (4.3)
Background therapy: Metformin + DPP-4 inhibitor, n (%)	25 (41.7)
Background therapy: Metformin + Sulfonylurea, n (%)	18 (30.0)
Background therapy: Metformin alone, n (%)	17 (28.3)
Mean adherence, % (SD)	90.6 (5.0)
Completed study, n (%)	60 (100)

3.2 Glycemic outcomes

All three glycaemic outcomes improved significantly from baseline to 12 weeks. Fasting blood glucose fell from a mean of 160.42 (SD 25.59) mg/dL to 135.87 (SD 27.42) mg/dL, a mean reduction of 24.55 mg/dL (95% CI −26.65 to −22.46; paired t=−23.46, df=59, p<0.001), corresponding to a large effect size (Cohen's d_z=−3.03). Postprandial blood glucose fell from 234.33 (SD 34.61) mg/dL to 197.25 (SD 35.28) mg/dL, a mean reduction of 37.08 mg/dL (95% CI −40.17 to −33.99; paired t=−24.01, df=59, p<0.001; d_z=−3.10). HbA1c fell from 8.12 (SD 0.73)% to 7.54 (SD 0.76)%, a mean reduction of 0.59 percentage points (95% CI −0.63 to −0.54; paired t=−25.72, df=59, p<0.001; d_z=−3.32). These findings are detailed in Table 2 and illustrated in Figures 1 and 2.

Table 2. Pre–post glycemic outcomes after 12 weeks of adjunctive fenugreek supplementation (N=60).

Outcome	Pre, mean (SD)	Post, mean (SD)	Mean change (95% CI)	Paired t (df=59)	p-value	Cohen's d_z
FBG (mg/dL)	160.42 (25.59)	135.87 (27.42)	−24.55 (−26.65 to −22.46)	−23.46	<0.001	−3.03 (large)
PPBG (mg/dL)	234.33 (34.61)	197.25 (35.28)	−37.08 (−40.17 to −33.99)	−24.01	<0.001	−3.10 (large)
HbA1c (%)	8.12 (0.73)	7.54 (0.76)	−0.59 (−0.63 to −0.54)	−25.72	<0.001	−3.32 (large)

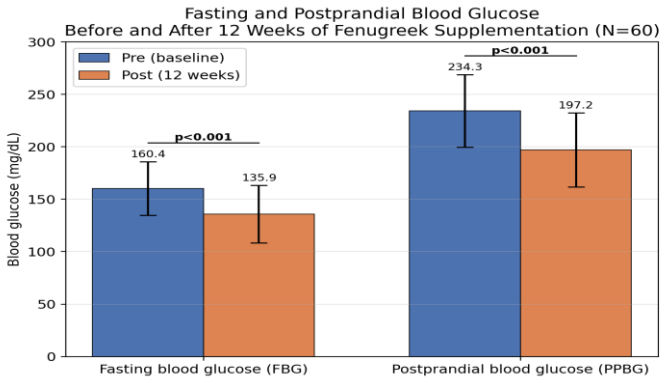

Figure 1. Grouped bar chart of mean fasting blood glucose (FBG) and postprandial blood glucose (PPBG) in mg/dL before (pre) and after (post) 12 weeks of fenugreek supplementation. Error bars denote standard deviations. Both reductions were statistically significant (p<0.001).

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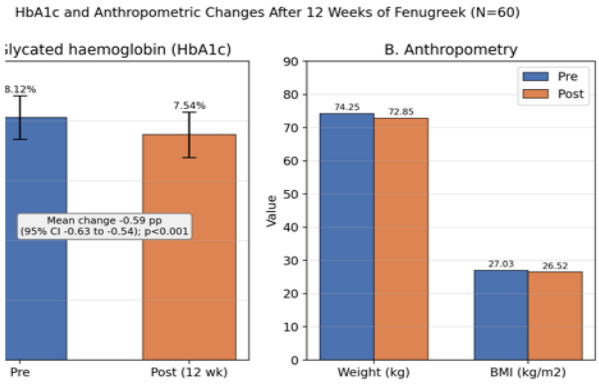

Figure 2. (A) Mean glycated hemoglobin (HbA1c, %) before and after supplementation, with the mean change of −0.59 percentage points annotated; (B) mean body weight and body mass index (BMI) before and after supplementation. Error bars denote standard deviations.

3.3 Anthropometric outcomes

Modest but consistent reductions were observed in body weight and BMI. Mean body weight decreased from 74.25 kg to 72.85 kg, a change of −1.40 kg (d_z=−1.76), and mean BMI decreased from 27.03 kg/m² to 26.52 kg/m², a change of −0.51 kg/m² (d_z=−1.67). These anthropometric changes are presented in Table 3 and the second panel of Figure 2.

Table 3. Anthropometric changes after 12 weeks of fenugreek supplementation (N=60).

Outcome	Pre, mean	Post, mean	Mean change	Cohen's d_z
Weight (kg)	74.25	72.85	−1.40	−1.76 (large)
BMI (kg/m²)	27.03	26.52	−0.51	−1.67 (large)

3.4 Adherence and adverse effects

The intervention was well tolerated. Mean adherence was 90.6% and there were no discontinuations. Mild adverse effects were reported by 8 of 60 participants (13.3%): bloating in 4, mild gastrointestinal discomfort in 3, and loose stools in 1. All events were mild, self-limiting and gastrointestinal in nature. There were no serious adverse events, no discontinuations, and no clinical or laboratory hepatic or renal safety signals. Adverse events are summarized in Table 4.

Table 4. Adverse effects reported during the 12-week intervention (N=60).

Adverse effect	n	% of participants
Bloating	4	6.7
Mild gastrointestinal discomfort	3	5.0
Loose stools	1	1.7
Any adverse effect (all mild)	8	13.3
Serious adverse events	0	0
Discontinuations	0	0

4. DISCUSSION

In this single-group pre–post study of 60 South Indian adults with T2DM, 12 weeks of adjunctive fenugreek seed powder (10 g/day) was associated with statistically significant and clinically meaningful reductions in fasting glucose, postprandial glucose and HbA1c, alongside modest reductions in weight and BMI, and with good tolerability. The magnitude of change was substantial: a mean FBG reduction of about 25 mg/dL, a PPBG reduction of about 37 mg/dL, and an HbA1c reduction of

approximately 0.6 percentage points [12-15]. The effect sizes were large by conventional standards. Nonetheless, as elaborated below, the uncontrolled design means these within-participant changes cannot be causally attributed to fenugreek.

Magnitude and clinical relevance. An HbA1c reduction of roughly 0.6 percentage points is of a magnitude that, if genuinely attributable to the intervention, would be clinically relevant, since even modest sustained reductions in HbA1c are associated with lower risk of microvascular complications. The particularly marked reduction in postprandial glucose is noteworthy, because postprandial excursions are an important contributor to overall glycemic load and cardiovascular risk in T2DM. The observed pattern—a proportionally larger fall in postprandial than in fasting glucose—is mechanistically consistent with a viscous soluble-fibre effect that predominantly blunts meal-related glucose absorption.

Plausible mechanisms. Several complementary mechanisms could plausibly underlie a glucose-lowering effect of fenugreek. The high galactomannan-rich soluble-fibre content increases luminal viscosity, slows gastric emptying and delays carbohydrate absorption, attenuating postprandial glycaemia and insulinaemia [16]. The amino acid 4-hydroxyisoleucine has been reported to enhance glucose-dependent insulin secretion and insulin sensitivity, while trigonelline, steroidal sapiens and dysgenic may exert additional metabolic and vascular effects [8,17]. Experimental studies suggest fenugreek constituents can preserve endothelium-dependent vascular function and mitigate diabetic complications such as cataract genesis and nephropathy through modulation of polyol-pathway activity, glucose transporters and the renin–angiotensin system [10,18]. These mechanisms provide biological plausibility, though they cannot be confirmed by the present clinical observations.

Comparison with existing evidence. Our observed direction and approximate magnitude of glycemic change are broadly consistent with the published literature. Recent systematic reviews and meta-analyses of randomized controlled trials have concluded that fenugreek supplementation reduces fasting glucose and HbA1c in people with diabetes and prediabetes, and some have additionally reported favorable effects on lipid and cardiovascular parameters [19,20]. Randomized trials comparing fenugreek with, or adding it to, standard oral agents have likewise reported glycemic improvements [5,21-23]. The improvements seen here sit at the upper end of reported effects, which is expected in an uncontrolled design where regression to the mean and co-interventions can inflate apparent benefit. Our findings therefore corroborate, rather than extend, the causal conclusions of the controlled literature.

Weight and tolerability. The modest reductions in weight and BMI are consistent with fiber-mediated increases in satiety and reduced energy intake, and may contribute indirectly to improved glycemic control. The favorable tolerability profile—only mild, self-limiting gastrointestinal symptoms in 13.3% of participants, no serious adverse events, and no hepatic or renal safety signals—accords with fenugreek's long history of dietary use and supports its acceptability as an adjunct.

South Indian dietary context and implications. Fenugreek (methi/vendhayam) is already a dietary staple across South India, used in curries, chutneys, spice blends and as sprouted seeds, which makes supplementation culturally familiar, inexpensive and readily scalable [24]. If the associations observed here were confirmed in controlled studies, fenugreek could represent a low-cost, food-based adjunct to conventional therapy that is particularly well suited to South Indian populations.

5.CONCLUSION

In this single-group pre–post study of adults with T2DM in South India, 12 weeks of adjunctive fenugreek seed powder (10 g/day) was associated with statistically and clinically significant reductions in fasting glucose, postprandial glucose and HbA1c, with large within-participant effect sizes, a modest reduction in weight and BMI, and good tolerability. Because the uncontrolled design cannot separate the effect of fenugreek from regression to the mean, placebo effects, concurrent pharmacotherapy and lifestyle factors, these results are hypothesis-generating rather than confirmatory. They support the conduct of a rigorously designed randomized controlled trial to establish whether fenugreek, a culturally embedded and low-cost functional food in South India, offers a genuine adjunctive benefit for glycaemic control in T2DM.

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