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NUTRITIONAL CHARACTERIZATION OF DIFFERENT PARTS OF KACHNAR (BAUHINIA VARIEGATA) IN MANAGING DIABETES MELLITUS

Original Research

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ABSTRACT

Background: Diabetes mellitus affects more than 537 million people worldwide and continues to rise at an alarming pace, particularly in low- and middle-income countries. Pakistan remains among the nations with the highest burden, where limited access, high treatment costs, and adverse drug reactions underscore the need for safer and affordable alternatives. Bauhinia variegata (Kachnar), a traditional South Asian medicinal plant, has gained scientific attention due to its rich nutritional composition and phytochemical profile, suggesting its potential usefulness in early metabolic intervention.

Objective: To evaluate the nutritional composition of selected parts of Bauhinia variegata and assess the antihyperglycemic effects of stem bark and leaf supplementation in individuals with prediabetes.

Methods: A comprehensive nutritional assessment was conducted on the leaves, flowers, and seeds of Bauhinia variegata, including proximate analysis, total phenolic content, DPPH radical scavenging activity, FRAP assay, and vitamin and mineral evaluation using standardized protocols. The stem bark and leaves—identified as the most nutrient-dense—were dried, powdered, and encapsulated. Sixty prediabetic adults (30–60 years) were randomly assigned into four groups: placebo (T0), 1 g/day (T1), 2 g/day (T2), and 3 g/day (T3). Fasting blood glucose (FBG), HbA1c, liver function tests (LFTs), and renal function tests (RFTs) were recorded at baseline and after 15 days. Statistical significance was set at $p < 0.05$.

Results: FBG values decreased progressively in all treatment groups, with T2 reducing from 119.48 ± 5.32 mg/dL to 100.06 ± 9.19 mg/dL and T3 from 121.48 ± 5.32 mg/dL to 98.83 ± 3.31 mg/dL. HbA1c demonstrated dose-dependent improvement, with T3 decreasing from 6.40 ± 0.20% to 6.01 ± 0.13%. Minimal change was observed in the placebo group. LFTs and RFTs remained within normal physiological limits across all groups, confirming short-term safety.

Conclusion: Bauhinia variegata stem bark and leaf supplementation produced a clear dose-response effect with significant antihyperglycemic action in prediabetic adults, suggesting its potential as a safe and accessible plant-based adjunct for early glycemic management.

Keywords: Antihyperglycemic Agents, Bauhinia variegata, Blood Glucose, Diabetes Mellitus, Dietary Supplements, Phytotherapy, Prediabetic State.

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Antihyperglycemic Effects of *Bauhinia variegata*

Background



537 million
people worlωide have diabetes

Objectives

Evaluate nutritional composition and antihyperglycemic effects *of Bauhinia variegata*



Methods

Dried Bauhinia stem bark and leaves

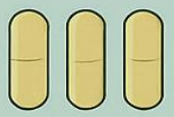




60
Prediabetic adults



Stem bark and leaves

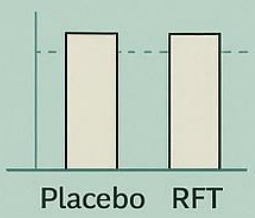


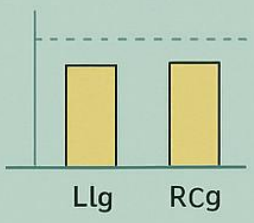
1 g/day
2 g/day

Results

Normal liver and kidney function







Results

Reduced fasting blood glucose and HbA1c



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INTRODUCTION

The global burden of diabetes mellitus (DM) has escalated rapidly over recent decades, positioning the disease among the most significant public health challenges of the 21st century. Current estimates from the International Diabetes Federation indicate that over 537 million adults are living with diabetes, a number projected to rise to 783 million by 2045, reflecting the aggressive trajectory of this metabolic disorder (1). Characterized by chronic hyperglycemia, diabetes induces a cascade of pathophysiological changes—including oxidative stress, endothelial dysfunction, and accelerated atherosclerosis—that substantially increase the risk of microvascular and macrovascular complications such as neuropathy, nephropathy, coronary artery disease, peripheral arterial disease, and cerebrovascular events (2). Without timely and effective management, these complications contribute to long-term disability, reduced quality of life, and premature mortality (3). The burden is particularly severe in low- and middle-income countries, including Pakistan, where nearly 11% of adults are affected, placing the nation among those with the highest prevalence rates worldwide (4). Conventional management strategies rely heavily on insulin therapy and oral hypoglycemic agents, which, although effective in glucose regulation, are associated with side effects, financial strain, and limited impact on disease reversal. These challenges have intensified the global interest in complementary and plant-based therapeutic approaches that are affordable, culturally acceptable, and potentially synergistic with existing treatment modalities (5).

Within this context, traditional medicinal plants used across South Asia have gained renewed scientific attention. Among these, Kachnar (Bauhinia variegata)—a deciduous tree recognized for its medicinal value—has emerged as a promising candidate for diabetes management. Historically used for endocrine, dermatological, respiratory, and gastrointestinal conditions, Kachnar contains a rich profile of bioactive compounds such as flavonoids, tannins, alkaloids, and saponins, which underpin its therapeutic actions (6). Contemporary evidence suggests that extracts from its leaves, bark, flowers, and stem exhibit antihyperglycemic properties by enhancing insulin sensitivity, reducing oxidative stress, modulating glucose absorption, and supporting weight regulation, all of which align with the multifactorial pathophysiology of diabetes (7,8). These findings underscore the potential role of Kachnar as an adjunctive nutritional and therapeutic intervention, particularly in resource-constrained settings where accessibility and affordability are key determinants of chronic disease management. Given the rising prevalence of diabetes and the urgent need for sustainable, multi-modal treatment strategies, further scientific evaluation of Kachnar's antidiabetic potential is both timely and essential. Therefore, this study aims to investigate the therapeutic role of Bauhinia variegata in diabetes management and assess its viability as a plant-based intervention to complement conventional care.

METHODS

The study was conducted using a randomized, controlled experimental design to evaluate the nutritional properties of Bauhinia variegata (Kachnar) and its therapeutic effects in individuals with prediabetes. Nutritional and phytochemical profiling of various plant parts—including leaves, flowers, and seeds—was performed through standardized analytical procedures assessing proximate composition, antioxidant activities (DPPH radical scavenging activity, FRAP assay, and total phenolic content), and micronutrient analysis for vitamin C and essential minerals such as calcium, iron, potassium, and zinc (9). Based on these analyses, the stem bark and leaves exhibited the highest concentration of bioactive compounds and nutritional value; therefore, these components were dried, converted into fine powder, and encapsulated for therapeutic use. A total of 60 male and female participants aged 30–60 years and diagnosed with prediabetes were recruited from Multan through purposive sampling. Eligibility required individuals not currently using any medication for glycemic control. Participants with severe chronic illnesses, known allergies to plant-based products, or physiological conditions such as pregnancy and lactation were excluded to ensure safety and homogeneity of the sample. Informed written consent was obtained from all participants prior to enrollment, and the study protocol adhered to the ethical guidelines of the Declaration of Helsinki. Ethical approval was secured from the Institutional Review Board (IRB) of the relevant institute.

Participants were randomly assigned into four groups of equal size (n = 15). The control group received placebo capsules (T0), while the treatment groups (T1, T2, and T3) received oral Kachnar-based capsules providing daily doses of 1000 mg, 2000 mg, and 3000 mg, respectively. These doses were delivered as two, four, or six 500 mg capsules per day to maintain consistency in capsule size and formulation. Biochemical evaluations were performed at baseline and post-intervention to determine the effects of Kachnar supplementation on glucose metabolism and systemic safety. Laboratory assessments included fasting blood glucose (FBG), postprandial blood glucose (PPBG), and glycated hemoglobin (HbA1c) to determine glycemic control, while liver function tests (LFTs) and renal function tests (RFTs) were conducted to monitor potential hepatotoxic or nephrotoxic effects. All biochemical analyses were

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carried out using standardized laboratory protocols. Data analysis was performed using SPSS software, with results expressed as mean ± standard deviation. Statistical significance was determined at $p < 0.05$, applying appropriate comparative tests to assess differences between the control and treatment groups. This analytical approach ensured rigorous evaluation of the therapeutic outcomes associated with Kachnar supplementation.

Table: Composition and Dosage Details of Kachnar-Based Treatment Groups

Treatment Group	Capsule Composition	Daily Dosage (Capsules per day)	Total Daily Intake (mg)
T_0	Placebo	02	0
T_1	500 mg Kachnar-based capsule	02	1000
T_2	500 mg Kachnar-based capsule	04	2000
T_3	500 mg Kachnar-based capsule	06	3000

RESULTS

The mean age of the study participants was 47 ± 6.93 years, with a minimum of 35 years and a maximum of 59 years. Among the 60 individuals enrolled, 24 (40%) were male and 36 (60%) were female. All participants met the diagnostic criteria for prediabetes prior to intervention. Fasting blood glucose levels were recorded at baseline and subsequently on the 6th, 10th, and 15th day following daily oral intake of Kachnar-based capsules. At baseline, mean fasting blood glucose ranged from 119.48 mg/dl to 125.86 mg/dl across groups. The placebo group showed minimal reduction over time, decreasing from 125.86 ± 6.92 mg/dl at baseline to 116.13 ± 6.20 mg/dl on the 15th day. In contrast, progressive declines were observed in the treatment groups. The 1 g group demonstrated reductions from 120.76 ± 4.79 mg/dl to 107.42 ± 7.71 mg/dl. The 2 g group exhibited further improvements from 119.48 ± 5.32 mg/dl to 100.06 ± 9.19 mg/dl, reaching normoglycemic range. The 3 g group showed a marked reduction from 121.48 ± 5.32 mg/dl to 98.83 ± 3.31 mg/dl by day 15. Overall, a clear dose-dependent antihyperglycemic effect was observed, with higher doses demonstrating more substantial reductions. HbA1c levels measured at baseline indicated that all groups were in the prediabetic to near-diabetic range, with values between 6.38% and 6.48%. By the 15th day, the placebo group showed negligible change (6.48 ± 0.25% to 6.46 ± 0.23%), whereas treatment groups demonstrated notable declines. The 1 g group declined from 6.38 ± 0.18% to 6.23 ± 0.29%, the 2 g group from 6.40 ± 0.20% to 6.14 ± 0.35%, and the 3 g group from 6.40 ± 0.20% to 6.01 ± 0.13%, approaching recommended glycemic targets. Safety assessment through liver function tests (LFTs) and renal function tests (RFTs) on the 15th day indicated that all parameters remained within normal physiological ranges, demonstrating no adverse hepatic or renal effects associated with Kachnar supplementation.

Table 1: Descriptive Statistics of Age

N	Min	Max	Mean age
60	35	59	47± 6.93

Table 2: Fasting Blood Glucose Trends During 15-Day Bauhinia variegata Supplementation

Group	Treatment	Fasting blood glucose level (mg/dl)			
		Basal value	6th day	10th day	15th day
To	Placebo	125.86± 6.92	120.25±7.06	118.18±6.35	116.13±6.20
T1	1g daily	120.76±4.79	117.76± 5.65	110.23±8.19	107.42±7.71

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Group	Treatment	Fasting blood glucose level (mg/dl)			
T2	2g daily	119.48±5.32	108.23±6.66	106.85±9.97	100.06±9.19
T3	**3g daily**	**121.48±5.32**	**112.61±5.07**	**98.36±3.52**	**98.83±3.31**

Table 3: Comparative HbA1c Levels at Baseline and After 15 Days of Bauhinia variegata Supplementation

Group	Basal Value	15th Day
Placebo	6.48 ± 0.25	6.46 ± 0.23
T1 (1g)	6.38 ± 0.18	6.23 ± 0.29
T2 (2g)	6.40 ± 0.20	6.14 ± 0.35
T3 (3g)	6.40 ± 0.20	6.01 ± 0.13

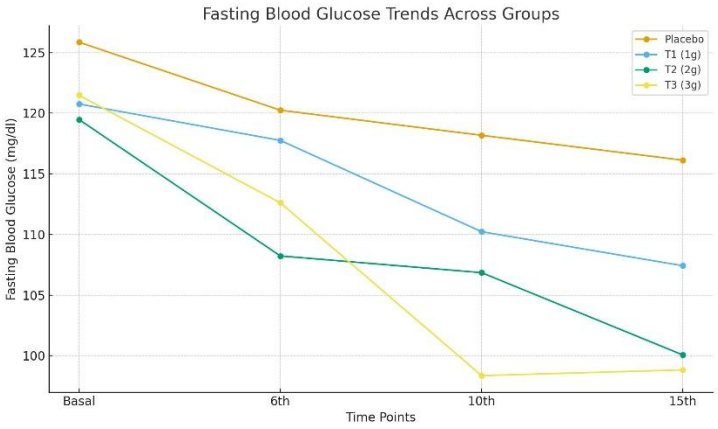


Figure 2 Fasting Blood glucose Trends Across Groups

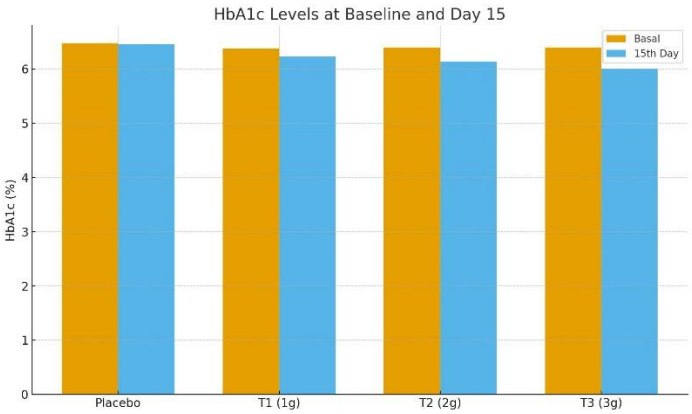


Figure 2 HbA1c levels at Baseline and Day 15

DISCUSSION

The findings of the present study demonstrated that Bauhinia variegata, particularly its stem bark and leaves, possessed considerable nutritional and phytochemical richness that aligns with previously documented evidence regarding its therapeutic value in metabolic disorders. The high concentrations of flavonoids, tannins, phenolic compounds, minerals, and antioxidant constituents provided a strong biochemical foundation for its potential antidiabetic effects. These characteristics have been repeatedly associated with improved glycemic control and metabolic regulation in earlier scientific work, and the present analysis reinforces those observations (10-12). The proximate analysis further supported the therapeutic relevance of these plant parts by highlighting substantial amounts of crude fiber and essential minerals, nutrients that contribute to enhanced digestive function and glycemic stability. Similar proximate assessments in prior studies confirmed the beneficial metabolic influence of fiber- and mineral-rich botanical preparations, indicating a consistent pattern across research findings (13,14). The antioxidant capacity recorded through DPPH, FRAP, and total phenolic content assays added further clarity to the mechanism of action. Oxidative stress remains a fundamental contributor to insulin resistance and beta-cell dysfunction, and the high free radical–scavenging activity observed in this study strongly supports the therapeutic plausibility of B. variegata extracts. Comparative investigations on Bauhinia species have similarly demonstrated significant reductions in oxidative biomarkers, supporting the broader understanding that phytochemical-rich plant extracts may counteract hyperglycemia-induced oxidative injury (15,16). These cumulative findings presented a coherent rationale for evaluating B. variegata in a clinical context. In the clinical phase, the dose-dependent reduction in fasting blood glucose among prediabetic participants showed a consistent and progressive therapeutic pattern. While the placebo group exhibited minimal changes, the treatment groups receiving 2 g and 3 g daily

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doses achieved reductions approaching normoglycemic values by day 15. This pattern mirrored earlier experimental work in which Bauhinia extracts demonstrated notable antihyperglycemic effects in both animals and humans (17,18).

The improvement in HbA1c values, especially in the highest dose group, further emphasized the clinical relevance of these findings. The observed reductions suggested enhanced insulin sensitivity, decreased intestinal glucose absorption, and improved peripheral glucose uptake, mechanisms previously described in studies assessing medicinal plant–derived antidiabetic agents. These effects aligned with broader literature reporting dose-dependent responses in botanical therapies, often linked to higher concentrations of bioactive phytochemicals (19,20). The implications of these findings hold particular significance in regions with rising diabetes prevalence and limited access to long-term pharmacological care. The absence of adverse effects in liver and renal function tests suggested good tolerability of the capsules, supporting the potential role of B. variegata as a complementary or preventive intervention. However, several limitations warrant consideration. The sample size, although adequate for a pilot study, limited the generalizability of the findings. The intervention period was short, and longer follow-up would be required to determine sustained glycemic control. Lifestyle factors such as diet and physical activity were not systematically monitored, although these variables significantly affect metabolic outcomes. Additionally, postprandial glucose levels, which were noted in the methodology, were not reported, thereby limiting the completeness of glycemic assessment. Despite these limitations, the study exhibited important strengths. It incorporated both biochemical profiling and clinical evaluation, ensuring a comprehensive analysis of the therapeutic potential of the plant. The use of standardized laboratory assessments strengthened the reliability of biochemical outcomes, while the dose-dependent clinical response enhanced the validity of the findings. Future research would benefit from larger multicenter trials, extended duration of supplementation, and mechanistic studies exploring molecular pathways of glycemic modulation. Comparative trials evaluating B. variegata alongside other established plant-based antidiabetic agents may further clarify its clinical positioning. Investigating its long-term safety, effects on insulin resistance indices, and potential role in preventing progression from prediabetes to diabetes would add significant value (21). Overall, the study contributed meaningful evidence to the growing literature supporting the antidiabetic potential of Bauhinia variegata. The dose-responsive improvements in glycemic markers, combined with the plant's nutritional and antioxidant profile, indicated that its stem bark and leaves could offer a viable adjunctive strategy for early metabolic intervention.

CONCLUSION

The study concluded that Bauhinia variegata stem bark and leaf powder possess meaningful antihyperglycemic potential, offering improvements in glycemic indicators among individuals with prediabetes. The plant's rich profile of bioactive and antioxidant constituents supports mechanisms that enhance insulin sensitivity and reduce oxidative stress, aligning with its observed dose-dependent therapeutic effects. The intervention demonstrated a favorable safety profile, suggesting that Kachnar may serve as a practical, accessible, and culturally acceptable plant-based adjunct to early diabetes management. These findings highlight its promise in preventive metabolic care, while underscoring the need for larger and longer-term studies to strengthen its clinical applicability.

AUTHOR CONTRIBUTIONS

Author	Contribution
Beenish Mushtaque	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Hamna Tahir	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Zarmina Taj	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published

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Author	Contribution
Nargis Aman	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Carita Johnson Dean	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Sana Saadat	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Rawia Sheikh	Contributed to study concept and Data collection Has given Final Approval of the version to be published
Fatima Ashraf Mughal*	Writing - Review & Editing, Assistance with Data Curation
Neelum Shahzadi	Writing - Review & Editing, Assistance with Data Curation

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