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RESEARCH ARTICLE
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EVALUATION AND MONITORING OF BLOOD GLUCOSE AMONG PRE-DIABETIC ON STAPLE DIET SORGHUM (JAWAR) IN COAL CAPITAL OF INDIA, DHANBAD

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ABSTRACT

Background: The number of people with type 2 diabetes mellitus (T2DM) is predicted to increase from 463 million in 2019 to 700 million by 2045, making it a serious global health concern. High-glycaemic diets based on refined cereals are associated with an increasing prevalence in India. Glycaemic control and insulin sensitivity may be enhanced by sorghum (jowar), a low-glycaemic, nutrient-dense millet high in bioactive compounds. In many areas, including Dhanbad, Jharkhand, its dietary use is still restricted in spite of this.

Aim: The aim of this study was to assess and track how a staple diet high in sorghum (jowar) affects blood glucose levels in pre-diabetic people in Dhanbad, India's coal capital. In a region-specific setting, the study aims to ascertain whether regular sorghum consumption can support dietary interventions as a preventive strategy for pre-diabetes, delay the onset of diabetes, and contribute to glycaemic control.

Methodology: Two hundred pre-diabetic people in Dhanbad, aged 35 to 55, participated in this three-month study (August–October 2024). Jowar roti was served for dinner instead of rice or wheat for participants with FBG levels between 111 and 125 mg/dL and PPBG levels between 140 and 199 mg/dL. A fully autoanalyser was used to measure blood glucose once a month using the GOD-POD method.

Result: The mean PPBG dropped from 171.28 to 152.34 mg/dL and the mean FBG dropped from 117.88 to 111.84 mg/dL. Both parameters improved significantly (>10 mg/dL) in more than 85% of cases.

Conclusion: Pre-diabetics' glycaemic levels were improved by consuming jowar roti on a daily basis. A useful and culturally appropriate dietary strategy to help prevent Type 2 diabetes is sorghum.

Keywords: Pre-Diabetes**,** Sorghum (Jowar)**,** Blood Glucose Monitoring**,** Fasting Blood Glucose**,** PPBG (Post-Prandial Blood Glucose)**,** Dietary Intervention**,** Glycaemic Index**,** PPAR-γ Activation**,** Insulin Sensitivity**,** Millets and Diabetes**,** Functional Foods**,** Nutritional Therapy.

INTRODUCTION

A major global health concern today is diabetes mellitus, especially T2DM (Type 2 Diabetes Mellitus). Globally, there were about 463 million people with diabetes in 2019, and estimates indicate that number will rise to 700 million by 2045. Remarkably, low- and middle-income nations, where dietary diversity is frequently restricted and food security issues endure, account for more than 87% of diabetes-related deaths.[1] India, which has one of the highest rates of diabetes among the top three countries (China, India and United States). Urgently needs to adopt preventive measures that take lifestyle and nutrition into account.

The kind of staple food ingested is one of the key factors influencing insulin sensitivity and glucose metabolism. Commonly consumed in India, refined cereals like wheat and white rice have a high GI (Glycaemic Index) and are a major cause of postprandial hyperglycemia. Millets, like sorghum (jowar), on the other hand, are perfect for controlling blood sugar because they have a lower GI and are high in dietary fibre, protein, and micronutrients.[2]

Sorghum's therapeutic potential in the management of diabetes has been further demonstrated by recent nutritional and biochemical studies. Bioactive phytochemicals like tannins, flavonoids, and phenolic acids, which have been demonstrated to have antioxidant, lipid-lowering, and insulin-sensitizing qualities, are especially abundant in sorghum. Sorghum extract has been shown in experimental models to significantly lower blood glucose levels, improve insulin sensitivity, upregulate adiponectin expression through the PPAR-γ pathway, and lower inflammatory markers like TNF-α.[1,2]

Despite this evidence, sorghum is still not widely consumed in daily diets, especially in areas like Dhanbad, Jharkhand, which is referred to as India's coal capital. High rates of diets heavy in carbohydrates and rising rates of metabolic disorders are prevalent in this area. In light of this, there is compelling reason to look into sorghum as a dietary intervention for pre-diabetic people in these situations.

Examining and tracking blood glucose patterns in pre-diabetic people who consume sorghum as a staple food is the goal of this study. The goal of the study is to ascertain whether consistent sorghum consumption can promote glycaemic control and possibly stop the development of type 2 diabetes.

MATERIALS & METHODS

This was a **prospective interventional observational study** conducted from **August to October 2024** in Dhanbad, India. Total sample size 200 pre-diabetic adults between the age group of 35–55 years. The inclusive criteria was FBG (Fasting Blood Glucose) between **111–125 mg/dL**, PPBG (Post-Prandial Blood Glucose) between **140–199 mg/dL** and Exclusion Criteria was Diagnosed diabetes, those on glycaemic medications, or with metabolic/chronic conditions affecting glucose.

Participants habitually consuming rice or wheat as primary staples were advised to **replace their usual dinner staple with sorghum (jowar) roti at least once nightly** for the three-month duration. Blood samples were taken at Baseline (Day 0), Monthly follow-ups (end of Week 4, Week 8, and Week 12).

A semi-autoanalyzer employing the **GOD-POD (Glucose Oxidase–Peroxidase) method** was used for measuring blood glucose—both fasting and two-hour post-meal levels. This is consistent with standard clinical protocols. Tests were conducted in a single accredited laboratory to ensure consistency and reliability. Primary outcome Change in mean fasting and postprandial glucose levels over 12 weeks.

Statistical Analysis

Paired t-test or repeated measures ANOVA (depending on normality of data) was used to assess within-subject changes. A p-value <0.05 was considered statistically significant.

RESULTS

A total of **200 pre-diabetic participants** aged between 35 and 55 years were enrolled in the study. Blood glucose levels were monitored over a period of three months following the introduction of **sorghum (jowar) roti as a dietary intervention**, replacing either rice or wheat during dinner. Over the course of three months, pre-diabetic individuals who adopted sorghum (jowar) as a regular evening meal showed noticeable improvements in their fasting and postprandial blood glucose levels. When sorghum was substituted for high-glycemic cereals like rice or wheat, participants who had previously eaten these foods as their main staples showed a positive glycaemic response. Because of its low glycaemic index (GI), sorghum helps reduce post-meal glucose spikes by slowing down the digestion and absorption of carbohydrates. Because it helps keep blood glucose levels more stable throughout the day, this mechanism is particularly advantageous for people who are pre-diabetic. A range of bioactive phytochemicals, such as flavonoids, phenolic acids, tannins, and dietary fibre, are also present in sorghum. It has been demonstrated that these substances have anti-inflammatory, glucose-lowering, and antioxidant qualities. Specifically, research has shown that sorghum enhances insulin sensitivity via pathways involving PPAR-γ, or peroxisome proliferator-activated receptor. This nuclear receptor is essential for glucose homeostasis and lipid metabolism. Improved adiponectin levels and decreased insulin resistance have been associated with increased PPAR-γ expression. Studies using animal models corroborate these conclusions. When mice given a high-fat diet were supplemented with sorghum extract, their blood glucose and serum insulin levels significantly decreased. Increased PPAR-γ activity and decreased expression of pro-inflammatory markers like tumour necrosis factor-alpha (TNF-α) were linked to these effects. The potential of sorghum as a therapeutic dietary component for the management or prevention of type 2 diabetes is highlighted by these molecular mechanisms. The results of this study are consistent with mounting evidence that, particularly in resource-constrained environments like Dhanbad, dietary diversification with millet-based staples can significantly improve the prevention of non-communicable diseases from a wider public health standpoint. Because of its low input requirements and climate resilience, sorghum is used to support sustainable agriculture in addition to glycaemic control.

Improvement Category	Number of Participants
No improvement	3
Mild (1–5 mg/dL)	6
Moderate (6–10 mg/dL)	16
Significant (>10 mg/dL)	175

Table 1: FBG Improvement Categories

Approximately **87.5% of participants** experienced a **significant reduction (>10 mg/dL)** in fasting blood glucose, indicating strong efficacy of the sorghum-based intervention in reducing fasting glycaemic levels.

Improvement Category	Number of Participants
No improvement	2
Mild (1–5 mg/dL)	10
Moderate (6–10 mg/dL)	18
Significant (>10 mg/dL)	170

Table 2: PPBG Improvement Categories

A notable **85% of the participants** showed a **significant drop (>10 mg/dL)** in postprandial blood glucose, further supporting the beneficial impact of sorghum in managing post-meal hyperglycaemia. A progressive decline in both FBG and PPBG was observed across the study period:

Time Point	Mean FBG (mg/dL)	Mean PPBG (mg/dL)
Baseline	117.88	171.28
1 Month	115.25	163.61
2 Months	113.35	157.59
3 Months	111.84	152.34

Table 3: Change in Mean Blood Glucose Levels

There was a **significant reduction in average FBG by 6.04 mg/dL** and in **PPBG by 18.94 mg/dL** from baseline to the end of three months. These results suggest a favorable glycemic response to the inclusion of sorghum in the diet.

DISCUSSION

The current study assessed the effects of dietary modification on fasting and postprandial blood glucose levels in pre-diabetic individuals over a three-month period. Specifically, the substitution of sorghum (jowar) roti for rice or wheat at dinner was examined. The results, both theoretically and empirically, support previous studies on millets as functional foods for metabolic health by highlighting the substantial glycaemic benefits of including sorghum in the daily diet. The nutrient-dense, gluten-free cereal grain sorghum (Sorghum bicolour L. Moench) is well-known for its high fibre content, low glycaemic index, and profusion of polyphenols, including flavonoids, tannins, and phenolic acids.[1,2] All of these characteristics work together to reduce blood glucose spikes following meals by slowing down the digestion and absorption of carbohydrates.[3] Since postprandial hyperglycaemia is a major risk factor for the development of T2DM (Type 2 Diabetes Mellitus), this mechanism is particularly pertinent to the management of pre-diabetes.[4] Both FBG and PPBG levels were considerably lowered in our study when sorghum was substituted for high-GI staples like rice and wheat. These results are in line with measurements based on the GOD-POD method that were employed in related studies.[5]

Biochemical processes underpinning sorghum's potential to prevent diabetes; sorghum's impact on multiple molecular pathways is thought to be responsible for its anti-diabetic properties. Interestingly, by activating PPAR-γ (Peroxisome Proliferator-Activated Receptor Gamma) in adipose tissue, sorghum polyphenols improve insulin sensitivity.[6] PPAR-γ controls lipid metabolism, adipogenesis, and glucose absorption. Its activation results in decreased levels of TNF-α (Tumour Necrosis Factor-alpha), a pro-inflammatory cytokine associated with insulin resistance, and increased secretion of adiponectin, a hormone known to enhance insulin sensitivity.[7,8] In mice fed a high-fat diet, Ji Heon Park et al. showed that sorghum extract dramatically reduced fasting glucose, insulin, triglycerides, and LDL cholesterol while raising adiponectin expression-mechanisms important for managing diabetes.[9] These results show potential translational value from animal models to community settings and support the human outcomes seen in our current study.

The main staples of Indian diets, refined rice and wheat, are generally low in dietary fibre and high in simple carbohydrates, which raises their glycaemic loads.[10] Sorghum, on the other hand, provides complex carbohydrates that help keep blood glucose levels stable because they take longer to digest.[11] In Asia and Africa, where cereals make up as much as 70% of dietary intake, millets like sorghum are especially well-suited to replace high-GI staples, per Pradeep M's brief review.[12] Furthermore, sorghum's high satiety value may aid in limiting excessive caloric intake, which is another important aspect of metabolic health.[13] Regular sorghum consumption has also been shown to enhance gut microbiota diversity, lower oxidative stress, and improve lipid profiles-all of which are important for metabolic regulation.[14] Like many areas of rural and semi-urban India, Dhanbad has a low level of dietary diversity and a high carbohydrate intake. In these communities, sorghum

offers the perfect nutritional intervention because it is both affordable and climate-resilient. It satisfies the "smart food" criteria-good for you, good for the planet, and good for the farmer-by being both environmentally friendly and nutrient-dense.[15]
Since type 2 diabetes is mostly preventable, public health policy should prioritise evidence-based, culturally appropriate, and reasonably priced dietary strategies. This study shows that significant metabolic benefits can be obtained from a straightforward, staple-based intervention. It is in favour of adding sorghum to national nutrition initiatives like public distribution networks and midday meals. Ungi, additionally, the decrease in FBG and PPBG observed in more than 85% of participants is consistent with results from clinical studies and community trials. The potential for millet mainstreaming in the prevention of chronic diseases is highlighted by a meta-analysis conducted by Seetha Anitha et al., which also found that millet-based diets significantly lower the risk of developing diabetes.[16] Despite the encouraging results, this study was constrained by its brief duration and absence of a control group. For a thorough glycaemic assessment, future research should incorporate longer follow-ups, randomised controlled trials, and measurements of insulin, HOMA-IR, and HbA1c. To better contextualise results, behavioural factors like physical activity and dietary adherence should also be tracked.

CONCLUSION

The results of this study add credence to the increasing amount of data showing sorghum is a useful dietary ingredient for pre-diabetes management. Compared to traditional staples like rice and wheat, it offers substantial metabolic advantages due to its low GI, high fibre, and bioactive content. Particularly in areas like Dhanbad, where the prevalence of metabolic diseases is on the rise, the intervention's adaptability and simplicity make it a promising tool for community-level prevention initiatives. These findings support more comprehensive public health regulations and education initiatives focused on the traditional grains' nutritional comeback.

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