



ISSN 2456-3110

Vol 8 · Issue 6

June 2023

Journal of
**Ayurveda and Integrated
Medical Sciences**

www.jaims.in

JAIMS

An International Journal for Researches in Ayurveda and Allied Sciences



Maharshi Charaka
Ayurveda

Indexed

Unlocking the therapeutic potential of Millets: A path to Diabetes Control

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ABSTRACT

Diabetes mellitus is a global health concern, with a rising prevalence and significant implications for public health. Lifestyle factors, including diet, play a crucial role in the development and management of diabetes. In recent years, there has been a growing interest in the potential of incorporating millets into dietary interventions for the prevention and management of diabetes. Millets, traditional grains rich in fibers, minerals, and phytochemicals, offer promising nutritional benefits and unique therapeutic properties that may positively impact blood glucose control and reduce the risk of diabetes-related complications. This manuscript reviews the existing literature on the role of millets in the prevention and management of diabetes mellitus, highlighting their potential mechanisms of action, impact on glycemic control, and implications for dietary recommendations.

Key words: Millets, Shree Anna, Siridhanya, Diabetes mellitus, Prevention, Management, Nutrition

INTRODUCTION

Diabetes mellitus is a prevalent chronic metabolic disorder characterized by elevated blood glucose levels, resulting from either insufficient insulin production or impaired insulin action. It poses a significant global health challenge, with an estimated 700 million individuals projected to be affected by diabetes by 2045.^[1] Lifestyle factors, particularly diet, play a crucial role in the prevention and management of diabetes.^[2] As the burden of this disease continues to escalate, there is a growing interest in exploring alternative dietary interventions that can complement existing strategies. Millets, a diverse group of small-

seeded grains, have a long-standing history of cultivation and consumption in many regions, particularly in Africa and Asia.^[3] Traditionally, millets were staple crops that provided sustenance and nutritional benefits to communities. However, with the advent of industrialization, urbanization, and the dominance of modern food systems, the consumption of millets has declined significantly, making way for more widely consumed staples such as rice, wheat, and maize. In recent years, there has been a resurgence of interest in millets due to their unique nutritional composition and potential health benefits. Millets are characterized by their high fiber content, micronutrient profile, and abundance of phytochemicals. These nutritional attributes have led researchers to investigate the role of millets in the prevention and management of diabetes mellitus. The potential benefits of millets in diabetes care are multifaceted. Firstly, the high fiber content in millets, including both soluble and insoluble fibers, can contribute to improved glycemic control by slowing down carbohydrate digestion and absorption, thus reducing postprandial glucose excursions. Secondly, the presence of essential minerals, such as magnesium, zinc, and iron, in millets can support optimal metabolic function and insulin action. Additionally, the

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Submission Date: 13/04/2023 Accepted Date: 22/05/2023

Access this article online

Quick Response Code



Website: www.jaims.in

DOI: 10.21760/jaims.8.6.25

phytochemicals present in millets, including phenolic compounds and flavonoids, possess antioxidant and anti-inflammatory properties, which may have a protective effect against diabetes-related complications. While some studies, have explored the glycemic response to millet consumption, the evidence base on the specific mechanisms of action and long-term effects of millets in diabetes management is still developing.

Ayurveda provides a comprehensive understanding of millets within the category of *Dhanya Varga*. Millets are referred to by various synonyms in *Ayurveda*, including *Kudhanya* (considered inferior among cereals),^[4] *Kshudra Dhanya* (denoting small-sized cereals)^[5], and *Trina Dhanya* (indicating cereals derived from grass).^[6] Millets possesses *Kashaya* and *Madhura Rasa, Katu Vipaka, Sheet Veerya, Laghu* and *Ruksha* in *Guna* and are generally *Kapha Pittahara, Vaatala* and *Rakta-Shamak*.^[7,8] Due to having these properties millets can be useful in metabolic disorders like diabetes. This manuscript aims to review the existing literature on the role of millets in the prevention and management of diabetes mellitus. By examining the impact of millets on glycemic control, potential mechanisms of action, clinical evidence, and dietary recommendations, this review seeks to contribute to the growing body of knowledge on the integration of millets into diabetes care strategies. By harnessing the nutritional potential of millets, it may be possible to develop sustainable dietary interventions that can effectively prevent and manage diabetes mellitus. Understanding the role of millets in the context of diabetes can not only inform individuals living with the disease but also guide public health policies, food production practices, and educational initiatives. Through comprehensive exploration and dissemination of the evidence, we can promote the integration of millets into a balanced and diverse diet, ultimately improving diabetes outcomes and global health.

AIM AND OBJECTIVES

Aim of this study is to review and analyze the potential therapeutic benefits of millets for the prevention and management of Diabetes Mellitus.

METHODOLOGY

In present study we searched various data base like google scholar, PubMed a review of the published documents. Documents search was done by using keywords 'Millets', 'Diabetes Mellitus', and 'Prevention and Management' and review of the relevant literature was done.

DISCUSSION

Nutritional composition of Millets

Fiber content and its implications for glycemic control:

Millets are known for their high fiber content, which is a key component contributing to their potential benefits in the prevention and management of diabetes.^[9] The fiber in millets can be categorized into two types: soluble and insoluble fiber. Soluble fiber forms a gel-like substance in the digestive tract, slowing down the absorption of glucose and promoting better glycemic control. Insoluble fiber adds bulk to the stool, aiding in proper digestion and preventing constipation.

Micronutrient profile and its relevance to diabetes management:

Millets exhibit a diverse micronutrient profile that includes essential minerals such as magnesium, potassium, phosphorus, and iron. Magnesium, in particular, plays a crucial role in glucose metabolism and insulin action.^[10] Studies have shown that magnesium deficiency is associated with an increased risk of developing type 2 diabetes.^[11] The presence of these micronutrients in millets makes them potentially beneficial for individuals with diabetes.

Phytochemicals in millets and their potential health benefits:

Millets contain various phytochemicals, including phenolic compounds, flavonoids, and lignans. These bioactive compounds possess antioxidant and anti-inflammatory properties, which may help reduce oxidative stress and inflammation, both of which are implicated in the development and progression of diabetes and its complications. The presence of

phytochemicals in millets adds to their potential therapeutic value in diabetes management.

Impact of Millets on Glycemic Control:

Glycemic index and glycemic load of millets:

The glycemic index (GI) is a measure of how quickly a food raises blood glucose levels compared to a reference food, usually glucose or white bread.^[12] Millets, in general, have a lower GI compared to refined grains like rice, wheat, and maize.^[13] This lower GI indicates that millets are digested and absorbed more slowly, resulting in a gradual and sustained release of glucose into the bloodstream. As a result, millets can help prevent sharp spikes in blood glucose levels, providing better glycemic control. The glycemic load (GL) takes into account both the quality and quantity of carbohydrates in a food. It is calculated by multiplying the GI of a food by the amount of available carbohydrates per serving and dividing it by 100. Millets, with their relatively low GI and moderate to high fiber content, generally have a lower glycemic load compared to refined grains. This means that consuming millets can lead to a smaller increase in blood glucose levels after a meal, reducing the burden on insulin production and potentially improving glycemic control.

Role of dietary fiber in regulating blood glucose levels:

Millets are rich in dietary fiber, which plays a crucial role in regulating blood glucose levels. Fiber slows down the digestion and absorption of carbohydrates, preventing rapid spikes in blood glucose levels. Soluble fiber, in particular, forms a gel-like substance in the digestive tract, delaying the emptying of the stomach and slowing down the release of glucose into the bloodstream. This slower release of glucose helps maintain more stable blood sugar levels and promotes better glycemic control.

The fiber in millets also provides a sense of satiety, promoting feelings of fullness and reducing the likelihood of overeating or consuming excessive amounts of high-glycemic foods. By including millets in the diet, individuals with diabetes can potentially better manage their blood glucose levels and reduce

the risk of complications associated with poorly controlled diabetes.

Effect of millet consumption on postprandial glucose response:

Studies have shown that incorporating millets into meals can lead to a reduced postprandial glucose response, characterized by a slower and less pronounced increase in blood glucose levels after a meal. This effect is attributed to the combination of factors, including the low GI, high fiber content, and presence of beneficial phytochemicals in millets. By modulating the postprandial glucose response, millets can help individuals with diabetes maintain more stable blood sugar levels throughout the day, reducing the need for excessive insulin secretion and potentially improving long-term glycemic control.

Potential Mechanisms of Action

Insulin sensitizing effects of millets:

Millets have been shown to possess insulin sensitizing properties, which can enhance the effectiveness of insulin in lowering blood glucose levels.^[14-16] The specific compounds responsible for these effects are still being investigated, but it is believed that the fiber and phytochemicals present in millets play a role. Insoluble fiber in millets can help improve insulin sensitivity by reducing insulin resistance and promoting better glucose uptake by cells. Additionally, certain phytochemicals found in millets, such as phenolic compounds and flavonoids, have been associated with improved insulin signalling and glucose metabolism.

Anti-inflammatory and antioxidant properties:

Chronic inflammation and oxidative stress are closely linked to the development and progression of diabetes and its complications.^[17-21] Millets contain bioactive compounds, including phenolic compounds, flavonoids, and lignans, which exhibit potent anti-inflammatory and antioxidant properties.^[22-24] These compounds help reduce the production of pro-inflammatory molecules and counteract the damaging effects of free radicals, thereby mitigating inflammation and oxidative stress. By reducing

inflammation and oxidative stress, millets may contribute to improved insulin sensitivity, better glycemic control, and reduced risk of diabetes-related complications.

Gut microbiota modulation and its impact on glucose metabolism:

Emerging evidence suggests that the composition and activity of gut microbiota play a significant role in glucose metabolism and insulin sensitivity. Millets, with their high fiber content, act as prebiotics, providing nourishment for beneficial gut bacteria.^[25,26] The fermentation of millet fibers by gut microbiota produces short-chain fatty acids (SCFAs), such as butyrate, which have been shown to have positive effects on glucose metabolism and insulin sensitivity. SCFAs can enhance the secretion of gut hormones that regulate appetite and blood glucose levels, as well as improve the integrity of the intestinal barrier. These effects contribute to better glycemic control and may help prevent the onset of diabetes.

Clinical Evidence on the Role of Millets in Diabetes Prevention and Management:

Glycemic control and millet consumption:

Several clinical studies have investigated the impact of incorporating millets into the diet on glycemic control in individuals with diabetes.^[27-30] These studies have consistently demonstrated favorable effects on postprandial glucose levels and glycated hemoglobin (HbA1c) levels. For example, a randomized controlled trial involving individuals with type 2 Diabetes found that replacing a portion of rice with finger millet for six weeks resulted in significantly lower postprandial glucose levels compared to a rice-based control group. Similarly, another study showed that substituting rice with foxtail millet significantly reduced HbA1c levels in individuals with type 2 diabetes over a period of three months. These findings highlight the potential of millet consumption in improving glycemic control and long-term glucose management in individuals with diabetes.

Lipid profile and cardiovascular health:

In addition to glycemic control, millets have shown positive effects on lipid profiles, which are closely

linked to cardiovascular health, a major concern for individuals with diabetes. Studies have reported that millet consumption can lead to improvements in lipid parameters such as reduced total cholesterol, low-density lipoprotein cholesterol (LDL-C), and triglyceride levels, while increasing high-density lipoprotein cholesterol (HDL-C) levels.^[31,32] These lipid profile improvements are beneficial in managing dyslipidemia and reducing the risk of cardiovascular complications associated with diabetes.

Weight management and satiety effects:

Obesity and weight management are important considerations in diabetes prevention and management. Millets, with their high fiber content and lower energy density compared to refined grains, can contribute to weight management efforts. Clinical studies have suggested that including millets in the diet can promote feelings of fullness and reduce calorie intake, thus aiding weight loss or weight maintenance.^[33,34] These effects are attributed to the satiating properties of millet fibers, which can help individuals with diabetes adhere to calorie-restricted diets and achieve sustainable weight management.

Micronutrient supplementation and metabolic health:

Micronutrient deficiencies, such as magnesium, zinc, and iron, are prevalent among individuals with diabetes and can negatively impact glucose metabolism and insulin sensitivity. Millets, being rich sources of these essential minerals, offer a natural means of addressing these deficiencies. Clinical studies have shown that millet consumption can improve micronutrient status and support optimal metabolic function in individuals with diabetes.

CONCLUSION

The rising prevalence of diabetes mellitus and its associated health complications necessitates effective prevention and management strategies. Millets, with their rich nutritional composition, offer promising potential in the fight against diabetes. Their low glycemic index, high fiber content, and beneficial phytochemicals make them valuable additions to a

diabetes-friendly diet. The clinical evidence discussed highlights the positive impact of millets on glycemic control, lipid profile, weight management, and micronutrient supplementation in individuals with diabetes. Millets have been shown to improve postprandial glucose levels, HbA1c levels, lipid parameters, and satiety. Moreover, their insulin sensitizing effects, anti-inflammatory properties, and modulation of gut microbiota contribute to their therapeutic potential. However, several challenges need to be overcome to fully realize the benefits of millets in diabetes prevention and management. Limited awareness, accessibility, and acceptance pose barriers that can be addressed through educational campaigns, culinary adaptations, and policy support. In conclusion, millets offer a promising dietary approach in the prevention and management of diabetes mellitus. By incorporating millets into the diet and addressing the challenges at hand, individuals with diabetes can potentially improve glycemic control, support overall health, and reduce the risk of diabetes-related complications. Further research, collaboration, and advocacy are essential to maximize the potential of millets and enhance their impact on diabetes prevention and management, ultimately leading to better health outcomes for individuals worldwide.

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How to cite this article: Poornima Mansoria, S.B. Singh. Unlocking the therapeutic potential of Millets: A path to Diabetes Control. *J Ayurveda Integr Med Sci* 2023;06:152-157.

<http://dx.doi.org/10.21760/jaims.8.6.25>

Source of Support: Nil, **Conflict of Interest:** None declared.
