

The MILLET MISSION: The potential to combat non-communicable diseases and future research opportunities in India

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INTRODUCTION

NCD Burden and the role of nutrition

Chronic diseases, often known as non-communicable diseases (NCDs), pose a significant threat to worldwide public health. As per World Health Organisation (WHO), NCDs account for 74% of all fatalities worldwide, with cardiovascular disease, cancer, respiratory disease, and diabetes being the leading causes.^[1] Inadequate nutrition, including diets heavy in sugar, salt, saturated and trans fats, and deficient in fruits, vegetables, whole grains, and lean protein sources, is a significant risk factor for NCDs. The World Health Organization suggests a diet rich in fruits, vegetables, whole grains, nuts, and seeds and low in processed foods, sugar, saturated and trans fats.^[2]

Research has shown that some dietary patterns, such as the Mediterranean diet and the DASH (Dietary Approaches to Stop Hypertension), can lessen the likelihood of developing NCDs and benefit the treatment of those who already have them.^[3] These diets encourage the consumption of minimally processed, unprocessed foods and restrict the consumption of processed and high-fat meals. In addition to food, additional lifestyle factors such as physical activity, avoiding cigarettes and excessive alcohol intake, and stress management can aid in the prevention and management of non-communicable diseases.^[3-9]

Millet-based foods are foods that contain millet as their major ingredient. Millet is a category of small-seeded grains commonly consumed around the world, particularly in Asia and Africa.^[10] There are different types of millet, like, pearl millet, proso millet, foxtail millet etc. This paper focuses mostly on pearl millet also known as *Cenchrus americanus*, which is common in India. Due to the presence of natural

constituents (polyphenols, polysaccharides, oil, isoflavones, etc.) in millet seeds, millet possesses health-promoting properties. Even though many of these health benefits have been demonstrated using animal models and in vitro studies, but there is a paucity of literature of beneficial effects on human intervention trials.^[10]

Millet-based foods are available in numerous forms, including millet porridge, which is considered as a popular breakfast meal in many nations, particularly in Africa and Asia. It can be prepared by heating millet grains in water or milk and adding honey, sugar, or fruit for sweetness. Millet flour can be used to make roti, chapati, and naan, among other forms of flatbreads. They are commonly used in Indian cuisine. Millet can be used as a base for casseroles or combined with vegetables, beans, or meat to create a nutritious and full meal. Millet can be popped like popcorn and seasoned with salt, butter, or spices to create a nutritious and delicious snack. Much research has explored the health advantages of millet-based foods, and the following are the most significant findings:

Low glycaemic index (G.I.) millet-based foods can help manage blood sugar levels. A study discovered that a low-GI diet is more efficient in reducing glycated hemoglobin and fasting blood glucose in patients with type 2 diabetes than a high-GI or control diet.^[11] An eight-week millet-based diet resulted in significant weight loss in overweight and obese participants, according to a study. Foods containing millet have

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Access this article online

Quick Response Code



Website:
www.iapsmupuk.org

DOI:
10.47203/IJCH.2023.v35i02.021

How to cite this article: Ramanathan V, Tripathi S, Bhattacharya S, Jahnavi G, Gupta P, Varshney S. The MILLET MISSION: The Potential to Combat Non-communicable Diseases and Future Research Opportunities in India. Indian J. of Com. Health. 2023;35(2):246-249.

Received: 16-04-2023, **Accepted:** 06-05-2023, **Published:** 30-06-2023

the potential to reduce blood pressure due to its low sodium nature. The consumption of millet-based diets decreased the blood pressure of hypertensive rats, according to a study.^[11] Antioxidants are abundant in millet-based diets,^[10,12] which can help to reduce inflammation and protect against chronic diseases, including heart disease and cancer. Millet-derived foods have antihypertensive, anti-inflammatory, antimicrobial, hypocholesterolemic, hypoglycemic, and anti-oncogenic properties and it has gut health-modifying characteristics through immunomodulation.^[10] A systemic review suggests that millet consumption over a period of 21 days to 4 months, there is a significant reduction in total cholesterol (T.C.), triacylglycerol, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and very low-density lipoprotein cholesterol (VLDL-C). Four investigations also observed that millet ingestion has normalized TC and triacylglycerol levels (<200 and <150 mg/dl, respectively). Millet-based meals also increased HDL-C by 6.0%, lowered blood pressure by 4.0 and 5.0%, and lowered BMI by 7.0%.^[11] Overall, these studies suggest that integrating millet-based items into the diet can support the control of metabolic disease. However, it is crucial to emphasize that millet should be consumed in moderation as part of a well-balanced diet, and persons with metabolic disorders should consult a healthcare provider before making dietary adjustments.

Mechanism of Action

Several mechanisms have demonstrated the effectiveness of millet-based meals in regulating metabolic illnesses such as diabetes, obesity, and hypertension. Some of the pathways by which millet-based foods can aid in the management of metabolic disorders include the following: Millet has a low glycaemic index, which means it promotes a slower and steadier rise in blood sugar levels than meals with a high glycaemic index, such as white bread and potatoes. This can enable diabetics to regulate their blood sugar levels. Millet has a high fiber level, which can aid in delaying digestion and improve feelings of fullness. This can aid with weight management and lower the likelihood of obesity.^[13,14] Millet is an excellent provider of numerous critical elements, such as magnesium, potassium, and vitamin B6.^[15] These nutrients contribute to a reduction in blood pressure and an improvement in insulin sensitivity, which are both essential for overall health. Millet is also abundant in antioxidants, which can reduce inflammation and protect against chronic diseases, including heart disease and cancer.^[10]

Millet is naturally gluten-free, making it a healthy alternative for individuals with celiac disease or gluten intolerance who must avoid gluten-containing grains such as wheat, barley, and rye. Including millet-based items into the diet can be a useful technique for the management of metabolic diseases. Nonetheless, it is crucial to highlight that millet should be consumed in moderation and as part of

a balanced diet. Before adopting dietary adjustments, people with metabolic problems should contact their healthcare provider or a trained dietitian.

Initiatives of the Indian government toward millet-based diet

According to the Ministry of Agriculture and Farmers ' Welfare reports, the millet crop area dropped by 60 percent in 2016-2017. This is due to a confluence of factors, including shifting dietary habits, declining demand, and diverting irrigated land to wheat and rice production. Women and children suffered as a result, with their vitamin A, protein, iron, and iodine stores depleting. On the Global Hunger Index (GHI), India is ranked 64 out of 81 countries. It's a sad reflection of our country's situation that we're the second worst in the world when it comes to children's malnutrition. This scenario will not improve as the Public Distribution System and the Targeted PDS are still in operation. This is because grains such as rice and wheat have always taken precedence over the distribution of millet. Despite its importance to both regional and national food security, millets are not a high-priority crop in Indian agriculture. The importance of millet has been shown by the arguments made above. After the U.N. General Assembly declared 2023 as the "International Year of Millets," there is a greater attention in revitalizing millet consumption. The Indian government has taken several steps to promote millet-based meals and increase their consumption. (Table 1) The primary objectives of MILLET MISSION were-

- "To generate awareness of the contribution of millet to food security and nutrition.

- To inspire stakeholders to improve sustainable production and quality of millets. AND

- To focus on enhanced investment in research and development and extension services to achieve the other two aims."

Listed below are examples of these initiatives: In 2023, the Indian government proclaimed 2023 as the "International Year of Millets" to promote the cultivation and consumption of millets throughout the nation.^[16,17] The government has started the Millet Mission to encourage millet production and increase millet consumption in the country.^[16,17] The mission seeks to increase the area under millet production, promote agricultural methods based on millet, and raise knowledge of the nutritional benefits of millets. At schools around the country, the government has implemented millet-based lunches. The objective is to offer school children nutritious and healthful meals while boosting millet consumption. The government is also pushing millet-based items, including millet-based cookies, snacks, and ready-to-eat meals. These products are being created to meet the rising demand for nutritional and healthy dietary options. The Government of India is also sponsoring millet cultivation and processing, product development, and marketing-related research and

Figure 1: The millet millstones

| Year | Initiatives |
|------|---|
| 2012 | Initiative for nutritional security through Intensive Millet Promotion (INSIMP) |
| 2013 | National Food Security (NFS) Act expanded to include coarse grains |
| 2017 | NITI Aayog releases the National nutrition Strategy for Nourishing India |
| 2018 | <ul style="list-style-type: none"> Millets officially declared as 'Nutri cereal' Made part of the National Food Security Mission Government declares 2018 as "National Years of Millets" |
| 2021 | U.N. General Assembly declaring 2023 as the 'International Year of Millets' |
| 2022 | Centre announces PLI scheme to encourage companies to manufacture millet-based food products |
| 2023 | International year of Millets |

development programs like “Integrated Cereals Development Programmes in Coarse Cereals ICDP-CC based Cropping Systems Areas under Macro Management of Agriculture -MMA, Initiative for Nutritional Security through Intensive Millet Promotion – INSIMP a part of Rashtriya Krishi Vikas Yojana – RKVY which is the only comprehensive initiative to support millet production, and Rainfed Area Development Programme – RADP: a component of the Rashtriya Krishi Vikas Yojana – RKVY.” These projects are a part of the government’s efforts to promote healthy and sustainable food systems throughout the nation. They intend to promote the use of millets, which are nutritious, healthy and environmentally friendly food options.^[14] Many other initiatives, such as the “India’s Wealth, Millets for Health” campaign, the “Millet Startup Innovation Challenge,” the “Mighty Millets Quiz,” and a “Logo and Slogan Contest,” have also recently been launched.

Future avenues of millet-based food research

In recent years, millet-based meals have gained popularity due to their potential health benefits and sustainability. Further research in this area could aid in elucidating the mechanisms underlying the health advantages of millets and their potential application in the treatment and prevention of metabolic disorders. These are some potential future avenues for millet-based food research:

Bioavailability

Understanding the nutritional composition and bioavailability of components in millets, such as minerals, vitamins, and phytochemicals, requires additional investigation. This can assist in gaining a better understanding of the potential health advantages of millet and how they can be utilized to treat micronutrient shortages.

Processing and Product Development

Research can emphasize on creating novel millet-based products and optimizing processing processes to enhance the

sensory quality, shelf life, and nutritious content of millet-based foods.

Effect on gut microbiota

Research can examine the effect of millet-based diets on the gut microbiota and how this may contribute to their possible health advantages, like curing chronic inflammatory diseases of gut. The efficiency of millet-based diets in controlling, averting, and preventing metabolic illnesses such as diabetes, obesity, and hypertension can be the subject of future research. This can include more translational research from animal to human.

Sustainability

Studies can examine the environmental impact of millet growing and processing in addition to the socioeconomic impact of supporting millet-based agricultural and food systems.

While it is evident that there is literature supporting the potential benefits of millets, many of the studies suffer from methodological issues such as observational designs, small sample sizes, and challenges with generalisability. It seems like a number of the published sources are animal studies - these would be particularly limited in their generalisability. Overall, additional interventional studies on humans regarding millet-based foods can contribute to the establishment of a healthy and sustainable food ecosystem by shedding light on their potential health advantages and sustainability.

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