

Millets in Modern Diets: A Comprehensive Review of Their Nutritional and Health Benefits

Kanak Lata Rai*

Department of Food, Nutrition and Public Health Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh, India

Corresponding Author Email ID: kanaklatarei983@gmail.com

Received: 12/07/2026

Accepted: 25/07/2026

Published: 30/09/2026

Abstract

The growing burden of diet-related disorders, micronutrient inadequacies and environmental challenges has intensified the need for nutritious, sustainable and culturally acceptable food choices. Millets, traditionally consumed cereals that are increasingly recognized for their nutritional and environmental value, offer a promising link between healthy diets and sustainable food systems. This review examines the nutritional characteristics, health-promoting potential, functional food applications and relevance of major and minor millets in modern diets. Millets provide dietary fiber, plant-based protein, minerals, vitamins and diverse bioactive compounds, including phenolic constituents. Their nutritional characteristics and generally favorable glycogenic properties, which vary according to millet type, processing and preparation, indicate their potential role in dietary strategies supporting metabolic health, satiety and overall dietary quality. Millets also have potential applications in the development of functional and value-added foods. Beyond nutritional benefits, several millet species are comparatively resilient to drought and can be cultivated under challenging agro-climatic conditions, making them relevant to climate-resilient food systems. However, wider consumption is influenced by consumer awareness, taste and texture preferences, preparation practices, product availability, affordability and processing limitations. Nutrition education, improved processing technologies, consumer-oriented product development and integration of millet foods into contemporary dietary patterns may help overcome these barriers. Millets should therefore be considered not merely as alternative cereals but as nutrition-sensitive crops with potential contributions to public health, functional food development and sustainable food systems.

Keywords: Millets; Nutritional Health; Functional Foods; Sustainable Diets; Public Health

Journal of Applied Pharmaceutical Sciences and Research, (2026);

DOI: 10.31069/japsr.v9i3.03

Introduction

Food systems are currently facing interconnected challenges related to malnutrition, non-communicable diseases, climate change, resource limitations and changing consumer preferences. Modern diets in many populations are increasingly characterized by refined cereals, highly processed foods and inadequate intake of dietary fibre and micronutrient-rich foods. These changes have increased interest in traditional and underutilized crops that can contribute to healthier and more sustainable dietary patterns.

Millets are small-seeded cereal grains belonging mainly to the grass family Poaceae. They include both major and minor millet species and have historically been cultivated and consumed in several parts of Asia and Africa. In India, millets have traditionally formed part of regional food cultures, particularly in areas where environmental conditions are less favourable for water-intensive cereal production.

The renewed interest in millets has been associated with their nutritional composition, functional potential, adaptability and environmental relevance. The Food and Agriculture Organization has highlighted millet crops as resilient cereals capable of growing in relatively harsh environments and under conditions where other crops may

perform less effectively. Their cultivation can contribute to diversification of food systems and improve the availability of nutritious cereal-based foods.

The nutritional value of millets is influenced by species, variety, cultivation conditions, maturity and processing. In general, millets provide carbohydrates as the major energy source along with protein, dietary fibre, minerals, vitamins and bioactive compounds. Their nutritional characteristics make them relevant to contemporary discussions on whole grains, functional foods and sustainable diets.

This review discusses the nutritional composition, bioactive components, potential health benefits, processing, functional food applications, sustainability and consumer-related aspects of millets, with particular emphasis on their role in modern diets.^[1]

Diversity and Classification of Millets

Millets are not a single cereal but a group of diverse crops with different nutritional, culinary and agronomic characteristics. Commonly consumed millet species include pearl millet, finger millet, sorghum, foxtail millet, little millet, kodo millet, barnyard millet and proso millet. Pearl millet is widely cultivated in dry and semi-arid regions and is recognized for

Table 1: Selected millets and their nutritional relevance

Millet	Important nutritional/functional characteristics	Common applications
Pearl millet	Protein, iron, zinc, fibre and bioactive compounds	Roti, porridge, fermented foods
Finger millet	Calcium, fibre and phenolic compounds	Porridge, roti, bakery products
Foxtail millet	Fibre, protein and minerals	Rice replacement, upma, breakfast foods
Little millet	Fibre and micronutrients	Traditional rice-based dishes
Kodo millet	Dietary fibre and phenolic compounds	Rice replacement, snacks
Barnyard millet	Fibre and minerals; useful in diverse cereal preparations	Porridge, rice replacement, snacks
Proso millet	Protein, minerals and dietary fibre	Bakery and cereal-based products
Sorghum	Fibre, protein and bioactive compounds	Roti, flour, snacks and beverages

its energy, protein, iron and zinc contribution. Finger millet is particularly known for its calcium content and is traditionally used in porridges, breads and other preparations. Foxtail millet, little millet, kodo millet and barnyard millet provide dietary fibre and minerals and can be incorporated into a variety of traditional and contemporary foods.

The nutritional differences among species provide opportunities for dietary diversification. Therefore, promoting millets as a group rather than focusing on a single species can increase the range of nutrients and food applications available to consumers.^[2]

Nutritional Composition of Millets

Millets are primarily sources of carbohydrates, but their nutritional value extends beyond energy provision. They generally contain protein, dietary fibre, lipids, minerals and B-group vitamins. According to Indian nutritional literature, millet grains commonly contain approximately 60–68% carbohydrate, 6–12% protein, 1.7–5.4% fat and approximately 6–12% dietary fibre, although values differ among species and varieties.^[3]

Carbohydrates and Dietary Fibre

Carbohydrates constitute the largest proportion of millet grains. However, the physiological response to millet-based foods depends on the type of carbohydrate, starch structure, fibre content, processing method and food preparation.

Dietary fibre is an important nutritional characteristic of many millets. Fibre contributes to satiety, bowel function and overall dietary quality. Increased consumption of fibre-rich whole grains may also support metabolic health when incorporated into an appropriate dietary pattern.

Protein

Millets contribute plant-based protein to the diet. Although cereal proteins may have limitations in certain essential amino acids, combining millets with pulses, legumes, dairy products, nuts and seeds can improve the overall protein quality of meals. Traditional combinations such as millet with pulses therefore remain nutritionally relevant. Such combinations can be adapted to contemporary meals including millet

bowls, mixed-grain preparations, savoury pancakes and balanced breakfast dishes.

Minerals and Vitamins

Millets provide several minerals, including iron, calcium, magnesium, phosphorus and zinc, although concentrations differ substantially among millet species. Finger millet is particularly recognized for its calcium content, while pearl millet can contribute iron and zinc. Millets also contain B-group vitamins and other micronutrients. Nevertheless, the actual nutritional contribution depends on portion size, dietary pattern, processing and bioavailability.

Bioactive Compounds and Anti-Nutritional Factors

Millets contain several biologically active compounds, including phenolic compounds, flavonoids, tannins and other antioxidant-related constituents. These compounds have contributed to the growing interest in millets as potential functional food ingredients.

However, millet grains also contain anti-nutritional factors such as phytates and tannins. These compounds can interact with minerals and proteins and may reduce nutrient bioavailability. Their presence should not be interpreted as making millet consumption undesirable; rather, appropriate processing can help modify these components.

Processing techniques such as soaking, germination, fermentation, dehulling, milling, cooking and roasting can influence nutrient availability, antinutritional factors and sensory characteristics.^[4,5]

Potential Health Benefits of Millets

Glycaemic Health

One of the most researched areas concerning millet consumption is glycaemic response. A systematic review and meta-analysis reported that millet-based foods generally demonstrated lower glycaemic index values than milled rice and refined wheat products. However, glycaemic response is not identical for all millet species or preparations.

The form in which millet is consumed is important. Milling, cooking, fermentation, processing and food formulation

Table 2: Examples of millet integration into modern diets

<i>Meal/application</i>	<i>Possible millet use</i>	<i>Key nutritional consideration</i>
Breakfast	Millet porridge, upma, pancakes	Add protein-rich foods and fruits/vegetables
Main meal	Cooked millet replacing part of rice	Combine with pulses and vegetables
Bakery	Millet-based breads, muffins, biscuits	Control sugar and fat; improve texture
Snacks	Roasted millet products, savoury snacks	Avoid excessive salt and fat
Beverages	Fermented millet beverages	Monitor sugar and processing
Functional foods	Fibre-rich or bioactive-containing formulations	Evidence-based formulation and portion control

can change starch digestibility and consequently affect postprandial glucose response. Therefore, it is inappropriate to classify every millet preparation as automatically low glycaemic.

Evidence from intervention studies also suggests that regular consumption of certain millet foods may improve markers of glycaemic control.

Cardio metabolic Health

Millet provides dietary fibre, minerals and bioactive compounds that may contribute to cardio metabolic health as part of an overall balanced diet. Some studies have reported favorable changes in lipid parameters following consumption of millet-based diets.

Potential mechanisms include increased fibre intake, changes in carbohydrate quality and the presence of bioactive components. However, these benefits should be considered in the context of the complete dietary pattern rather than attributed to millets alone.

Satiety and Weight Management

Foods containing dietary fibre and less refined carbohydrate may contribute to greater satiety. Millet-based meals can therefore be useful in dietary patterns designed to improve meal quality and reduce excessive consumption of refined cereal products.

However, millet itself is not a weight-loss food. Energy intake, portion size, cooking methods and the overall composition of the diet remain important determinants of body weight.

Gut Health

The dietary fibre present in whole millet grains may support gastrointestinal function. Fibre can contribute to stool bulk and may influence the gut microbial environment.

The relationship between millet consumption and gut microbiota is an emerging area of research. More human studies are required to establish specific effects on microbial composition and long-term gastrointestinal health.

Micronutrient Contribution

Millet can contribute minerals such as iron, calcium, magnesium and zinc to the diet. This is particularly relevant in populations where cereal foods contribute substantially to total energy intake.

However, mineral content alone does not guarantee high bioavailability. Processing methods and dietary combinations influence mineral absorption. Combining millet foods with vitamin-C-rich vegetables or fruits and using appropriate processing techniques may help improve the nutritional quality of meals.

Millet in Modern Diets

The role of millets in modern diets is expanding beyond traditional preparations. Increasing consumer interest in health, convenience and sustainable foods has created opportunities for millet-based products.

Millet can be incorporated into breakfast foods, main meals, snacks, bakery products and beverages. Millet flour may be used in rotis, pancakes, muffins and other baked products. Cooked whole millet can replace or partially replace rice in meals. Millet-based porridges can be modified with milk, curd, fruits, nuts and seeds to create nutritionally balanced breakfast options.

For working populations, convenience is an important consideration. Ready-to-cook millet mixes, breakfast cereals, snack products and instant preparations may help increase accessibility. However, product formulation should avoid excessive addition of sugar, sodium or saturated fat merely to improve palatability.

The objective should not be to replace every conventional cereal with millet. Instead, millet can be incorporated as one component of a diversified dietary pattern.

Millet as Functional Foods

Functional foods are generally understood as foods that provide benefits beyond basic nutritional requirements. Millets have attracted attention in this area because they contain dietary fibre and various bioactive compounds.

Potential functional food applications include high-fibre breakfast products, millet-based fermented foods, snacks, bakery products and cereal-legume formulations. Germination and fermentation may further modify nutrient availability and bioactive characteristics.

However, functional food claims should be supported by scientific evidence. The presence of a bioactive compound in a food does not automatically establish a clinical benefit in humans. Product development should therefore be accompanied by nutritional evaluation, sensory testing and, where appropriate, clinical validation.

Processing, Value Addition and Product Innovation

Traditional millet grains require appropriate processing to improve palatability, digestibility and convenience. Dehulling, soaking, germination, fermentation, roasting, milling and cooking can modify the nutritional and functional characteristics of millet.

Processing can also reduce certain anti-nutritional factors. Germination and fermentation may improve nutrient availability and alter the sensory characteristics of millet foods.

Modern food processing provides opportunities for developing products that fit changing lifestyles. Millet-based pasta, noodles, breakfast cereals, extruded snacks, bakery products, instant mixes and fermented foods are examples of potential value-added applications.

Nevertheless, processing must be carefully designed. Excessive refining may reduce the advantages associated with whole grains, while highly processed millet products may contain considerable quantities of sugar, sodium or fat. Therefore, the term "millet-based" should not automatically be interpreted as "healthy".^[6]

Millets, Sustainability and Food Security

The importance of millets extends beyond nutrition. Several millet species can grow under relatively dry and challenging conditions and may require fewer external inputs compared with some water-intensive cereal systems.

Their adaptability makes millets relevant to climate-resilient agriculture. Diversification of cereal production can reduce dependence on a limited number of staple crops and may contribute to greater resilience of food systems.

Millets may also support local food cultures and rural livelihoods when value chains are developed effectively. However, sustainability benefits vary according to production practices, processing, and transportation and consumption patterns. Therefore, millet promotion should be integrated into broader sustainable food-system strategies rather than considered a single solution to environmental problems.

Consumer Acceptance and Challenges

Despite their nutritional potential, wider adoption of millets faces several challenges. Consumer acceptance is influenced by taste, texture, appearance, familiarity, cooking time, availability, price and family food preferences. Research among Indian consumers has identified lack of awareness, limited availability, price perceptions and resistance within households as important barriers. Social networks and family influence may also affect food choices. Some consumers associate millet foods with traditional or rural diets, whereas others perceive them as premium health foods. Both perceptions can influence purchasing behaviour. Food industries can address these barriers by improving product quality, convenience and sensory characteristics. Affordable products and clear nutrition information may also support wider adoption.^[7,8]

Role of Nutrition Education and Dietitians

Nutrition education is important for translating the nutritional potential of millets into practical dietary behaviour. Consumers need more than information about nutrient content; they need practical guidance on selection, preparation, portion size and meal combinations.

Dietitians and nutrition professionals can play an important role by incorporating millet foods into individualized meal plans according to nutritional requirements, cultural preferences and health conditions. For individuals with diabetes, for example, the emphasis should be on appropriate portions, total carbohydrate intake, meal composition and blood-glucose monitoring rather than simply recommending millet as a "diabetic food." Similarly, for weight management, millet should be incorporated into an overall calorie-appropriate diet. For children and older adults, texture, digestibility, nutrient density and acceptability should be considered. Nutrition education programmes can include demonstrations of simple millet recipes, comparison of traditional and modern preparations, label-reading activities and guidance on balanced meal combinations.

Future Perspectives and Research Gaps

The future potential of millets is considerable, but several research gaps remain.

First, more long-term human intervention studies are required to establish the effects of specific millet varieties and preparations on metabolic health. Second, research should distinguish between whole millet grains, millet flour and highly processed millet products because their nutritional and physiological effects may differ.

Third, greater attention should be given to bioavailability of minerals and the interaction between millet consumption and overall dietary patterns. Fourth, consumer research should explore affordability, accessibility and culturally appropriate methods of increasing millet consumption.

There is also scope for developing convenient millet foods with improved sensory characteristics while retaining nutritional quality. Food technology, nutrition science and public health research should therefore work together. Future research may also explore personalized nutrition approaches in which millet-based foods are selected according to individual metabolic characteristics, dietary preferences and lifestyle patterns.^[9]

Conclusion

Millets represent an important link between nutrition, health, food innovation and sustainability. Their contribution of dietary fibre, plant-based protein, minerals and bioactive compounds makes them valuable components of diversified diets. Evidence also indicates potential benefits for glycaemic and cardio metabolic health, although these effects vary according to millet type, processing and dietary context.

The modern role of millets should extend beyond traditional consumption. Through appropriate processing

and product innovation, they can be incorporated into breakfast foods, main meals, snacks, bakery products and functional foods. At the same time, the environmental resilience of several millet species makes them relevant to sustainable and climate-resilient food systems.

However, increased millet consumption cannot be achieved through promotion of nutritional benefits alone. Consumer awareness, affordability, accessibility, sensory acceptability and practical cooking knowledge must also be addressed. Nutrition education and professional dietary counselling can help translate scientific evidence into realistic dietary practices.

Millets should therefore be viewed not simply as alternative cereals but as versatile, nutrition-sensitive and sustainability-oriented foods. A coordinated approach involving researchers, nutrition professionals, food industries, farmers, policymakers and consumers can help transform the renewed interest in millets into meaningful contributions to healthier diets and resilient food systems.

References

1. Anitha, S., Kane-Potaka, J., Tsusaka, T. W., Botha, R., Rajendran, A., Givens, D. I., Parasannanavar, D. J., Subramaniam, K., & Nedumaran, S. (2021). A systematic review and meta-analysis of the potential of millets for managing and reducing the risk of type 2 diabetes mellitus. *Frontiers in Nutrition*, 8, 687428.
2. Food and Agriculture Organization of the United Nations. (2023). *Millets: Climate smart seeds of the future*. FAO.
3. Jacob, J., et al. (2024). The nutrition and therapeutic potential of millets: An updated narrative review. *Frontiers in Nutrition*, 11, 1346869.
4. Khan, T., Azad, A. A., & Islam, R. U. (2025). Millets: A comprehensive review of nutritional, antinutritional, health, and processing aspects. *Journal of Food Composition and Analysis*, 141, 107364.
5. Malathi, V. M., Venkateswarlu, R., Jacob, J., & Ratnavathi, C. V. (2023). Nutritional value of millets. *Indian Farming*, 73(1), 88–90.
6. Ravi, R., & Rana, G. (2024). Processing technologies and shelf-life aspects of millet-based foods. *ACS Omega*, 9(37), 38327–38347.
7. Singh, A., & Vemireddy, V. (2023). Consumer perceptions, awareness and barriers related to millet consumption in urban India. *BMC Public Health*, 23, 2003.
8. Siroha, A. K., & Bangar, S. P. (2024). Millet-based food products: An overview. *Current Food Science and Technology Reports*, 2, 213–220.
9. Yousaf, M. S., et al. (2021). Processing techniques and their effects on the nutritional and functional characteristics of millets. *Food Research International*, 142, 110197.

How to cite this article: Rai KL. Millets in Modern Diets: A Comprehensive Review of Their Nutritional and Health Benefits. *Journal of Applied Pharmaceutical Sciences and Research*. 2026; 9(3):22-26 Doi : 10.31069/japsr.v9i3.03