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REVIEW ARTICLE

Importance and Health Benefits of Millets in Present Scenario: A Superfood and Forgotten Grains

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ABSTRACT

Millets have been a staple in human diets for millennia, particularly in Africa and Asia. The most commonly cultivated millets globally, with a significant presence in India, include pearl millet, finger millet, foxtail millet, Indian barnyard millet, *kodo* millet, little millet, and proso millet. In Ayurveda, millets are classified under *Dhanya Varga* and are known by different names such as *Trina Dhanya, Kudhanya*, and *Kshudra Dhan*ya in various *Samhitas*. In addition, indigenous communities have traditionally used millet for medicinal purposes and to combat hunger. Millets are a hardy crop, thriving in poor soil conditions with minimal rainfall. The small "grain" is free from gluten and filled with essential vitamins and minerals. Millet grain is extremely nourishing, containing high-quality protein, abundant minerals, dietary fiber, phytochemicals, and vitamins. When comparing the nutritional content of millets to that of rice and wheat, it is evident that foxtail millet, proso millet, and pearl millet have higher protein content than wheat. Millets have emerged as a potential solution to address the present challenges in agriculture, food security, and public health. This is primarily due to the decline in the production of primary staple crops caused by shifting agroclimatic conditions. However, millets have demonstrated remarkable adaptability and possess a highly nutritious composition, making them a promising alternative.

1. INTRODUCTION

Ayurveda outlines three essential components of life: *Aahar* (nutrition), *Nidra* (sleep), and *Brahmacharya* (abstinence). (Unit), 2023) These elements play a crucial role in maintaining the balance of the three *doshas (Vata, Pitta, and Kapha*), nurturing the body, mind, and spirit. Ayurveda advocates for the preservation of health through the consumption of *pathyaahara*, or wholesome foods, with millets being recognized as a nourishing option in *Ayurvedic* texts.[1] The origin of the English term "Millet" can be traced back to the French word "Mille," meaning "Thousand." This etymology implies that even a small quantity of millet holds a multitude of grains.[2]

Millets, small-grained annual cereals from the grass family, thrive in warm weather and are typically rainfed. These hardy grains have minimal water and fertility needs compared to other common cereals and exhibit remarkable tolerance to drought and various extreme weather conditions. In India, millets held a traditional place in diets, but with the advent of the Green Revolution in the 1960s, they were marginalized as "orphan crops," becoming less consumed and nearly forgotten. Before the Green Revolution, millets accounted for approximately 40% of all cultivated grains, a figure that has dwindled to around 20% over time.[3] Not only has millet consumption decreased, but the land previously dedicated to their cultivation has been[4] up planted by commercial crops such as oilseeds, pulses, and maize. The Government of India recognized the significance of millet in enhancing nutritional security within the nation and implemented various initiatives. These included designating millets as Nutri-Cereals, commemorating the National Year of Millets in 2018, and implementing several targeted policies concerning millets on a smaller scale. The Government of India, under the leadership of Prime Minister Narendra Modi, led the initiative for a United Nations General Assembly (UNGA) resolution declaring 2023 as the International Year of Millets.[4] India's proposal garnered support from 72 countries,

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leading to the official declaration by the UNGA in March 2021. Despite being recognized as a superfood, millets are increasingly perceived as "food for the economically disadvantaged" in prevailing public perception. "Minor millets, also known as small millets, hold promise in aiding the impoverished and the most susceptible segments of society, offering a means to ensure food and nutrition security for the nation, particularly amidst challenges like the ongoing COVID-19 pandemic."

The Bhavprakash Nighantu describes the general characteristics (*Guna)* and actions *(Karma*) of millets as follows: they possess a taste profile of astringent (*Kashaya*) and sweet (*Madhur*), with a pungent (*Katuvipaka)* taste after digestion *(Nighantu*).[5] Millets exhibit a cooling potency (*Sheetavirya*) and are considered light (*Laghu*) and dry *(Ruksha*), with properties such as scraping (*Lekhan*), aphrodisiac (*Vrishya*), moisture-reducing *(Kledashoshan*), and binding *(Baddhamalkarra*). Their effects on the *doshas* include aggravation of *Vata*, mitigation of *Kapha* and *Pitta*, and purification of blood.[5]

2. MATERIALS AND METHODS

- Ayurvedic classical text
- Research Articles and journals

2.1. Classification of Millets: Mainly Classified in Two Categories

1. Major millets (sorghum millets and pearl millets)
2. Minor millets (finger millet, proso millet, foxtail millet, barnyard millet, and little millet, kodo millets).

2.1.1. Sorghum millets

Sorghum, an age-old grain, holds a significant place as a staple cereal in many regions of India. Jowar, a type of sorghum, is esteemed for its nutritional superiority over rice and wheat, offering a richer nutrient profile that can address diverse health concerns. Studies indicate that sorghum wax contains high levels of a nutrient known as policosanols, which play a crucial role in lowering cholesterol levels.[6]

2.1.2. Pearl millets

Pearl millet stands out as a nutrient-rich grain, on par with widely consumed cereals such as wheat and rice, and offers numerous added advantages. Its abundant fiber content supports weight loss and promotes healthy digestion. In addition, its phosphorus richness contributes to maintaining strong bones. With its elevated magnesium levels, pearl millet is notably effective in mitigating respiratory conditions such as asthma.[7]

2.1.3. Finger millets

Finger millet, commonly known as ragi, boasts an impressive calcium content of approximately 364 mg/100 g of grains, which is 3 times higher than that of milk. This calcium-rich grain contributes to maintaining strong bones and teeth. Finger millet is a notable source of essential nutrients, particularly iron, calcium, and phosphorus. Its antioxidant qualities, including phytochemicals, contribute to its easy and gradual digestion. Renowned for its holistic health benefits, finger millet aids in maintaining bone density, regulating blood cholesterol, facilitating weight loss, and reducing the risk of anemia. Versatile in culinary applications, it can be incorporated into various dishes such as roti, porridge, and pancakes, while also lending itself well to bakery products. Its exceptional malting properties have led to increased acceptance in food processing, highlighting the grain's uniqueness.[8]

2.1.4. Proso millets

Like other millets, proso millet is abundant in fiber, protein, and minerals. Its protein content aids in raising HDL cholesterol while reducing LDL and harmful cholesterol levels. Rich in lecithin, it supports the maintenance and repair of the neural health system. In addition, proso millet boasts substantial levels of B-complex vitamins, folic acid, and niacin. Its potent antioxidant properties offer potential protection against cardiovascular diseases and certain cancers.[8]

2.1.5. Foxtail millets

Foxtail millet offers a significant array of nutrients, including protein, vitamins, and minerals. Its grains have a coarser texture compared to other cereals, resulting in a digestibility rate of approximately 79%, with the remaining portion being indigestible fiber. These characteristics yield numerous health benefits, such as reducing the risk of degenerative diseases. Renowned for its high magnesium content, foxtail millet is recognized as a heart-healthy food. Its nutritional richness has cemented its status as a vital ingredient in various dishes, ranging from cereal porridge to pancakes, noodles, soup, and even the production of alcoholic beverages.[8]

2.1.6. Barnyard millets

The nutritional profile of barnyard millet is regarded as either superior to or on par with that of other major and minor cereals. Its elevated crude fiber content facilitates a gradual and steady release of sugars into the bloodstream, contributing to the maintenance of stable blood sugar levels. Alongside adequate amounts of other essential nutrients, barnyard millet notably boasts high iron levels, ranging from approximately 15.6 to 18.6 mg/100 g. This attribute positions barnyard millet as an optimal dietary choice for individuals with anemia and various lifestyle disorders. In comparison to other cereal grains, it also contains significant levels of polyphenols and carotenoids.[8]

2.1.7. Little millets

Little millet, a distinct minor cereal widely cultivated in tropical regions, serves as a staple food for certain economically disadvantaged populations globally. It offers a similar nutritional profile to other cereals, such as rice and wheat, providing protein, fat, carbohydrates, and crude fiber, along with essential minerals and vitamins. In addition, it contains phytochemicals such as flavonoids, phytate, phenolic acids, and tannins.

Despite its small size, little millet might have a lower nutrient density compared to other grains. However, it contains noteworthy levels of B vitamins and various minerals such as calcium, iron, zinc, and potassium. These nutrients, along with essential fats, can aid in weight loss. In addition, its high fiber content makes it a great substitute for rice in dishes, such as Pongal or Kheer.[9]

2.1.8. Kodo millets

Kodo millet, a traditional food with a flavor resembling rice, is renowned for its weight loss benefits. It is easily digestible and rich in phytochemicals and antioxidants, which play a vital role in preventing various diseases linked to a sedentary lifestyle.[10]

2.2. Importance of Millets

2.2.1. Climate resilient crop

Millets, recognized as climate-resilient crops, offer a sustainable solution to addressing hunger amidst a changing global climate. Their resilience to climatic stress, pests, and diseases makes them invaluable. Moreover, millets necessitate minimal water and other resources, making them a sustainable approach to mitigating climate change and establishing resilient agricultural systems.

2.2.2. Nutritional security

Nutri-cereals, packed with essential nutrients such as iron, folate, calcium, zinc, magnesium, phosphorus, copper, vitamins, and antioxidants, provide a nutritional boost. Millets, specifically, are rich in dietary fiber. Their gluten-free nature and low glycemic index make them beneficial for individuals with diabetes, aiding in the prevention of heart disease and nutritional deficiencies.

2.2.3. Economic security

Millets can thrive in various challenging environments such as arid, infertile, mountainous, tribal, and rainfed regions. With shorter cultivation cycles and minimal requirements, millets are not only beneficial for the land but also cost-effective to grow. These qualities mean that farmers can start millet production with a small initial investment, making it a promising source of income.

Millets are adaptable to various cropping systems, particularly in dryland and drought-prone regions. They exhibit resistance to numerous pests and diseases and do not negatively impact succeeding crops through allelopathy. In addition, millets can be seamlessly integrated with animal husbandry practices.

2.3. Health-Associated Benefits of Millets

1. Millets are rich in carbohydrates (about 65%), essential amino acids, proteins (around 9%), fats (approximately 3%), and dietary fiber (ranging from 2% to 7%). They also serve as significant sources of vitamins such as A, C, and B-complex, along with essential minerals, such as magnesium, manganese, phosphorus, and iron. Compared to maize and barley, millets contain approximately 60% more crude protein, 40% higher levels of lysine and methionine, and 30% more threonine. In addition, they boast a variety of antioxidants and bioactive compounds, such as resistant starch, oligosaccharides, lipids, flavonoids, phenolic acids, lignans, and phytosterols, which offer various health benefits. Millets are considered valuable nutraceuticals and functional food ingredients, particularly beneficial for managing health conditions such as celiac disease due to their gluten-free nature. Studies suggest that millets may contribute to cancer prevention by reducing tumor development risks, as well as offering cardiovascular benefits such as lowering blood pressure, cholesterol levels, and fat absorption. They also aid in delaying stomach emptying and providing gastrointestinal bulk.
2. Maintenance of probiotic and prebiotic balance in the body: Probiotics play a crucial role in maintaining a healthy population of beneficial bacteria in the colon, especially when it is depleted due to illness, chemotherapy, or antibiotics. These are living microorganisms that, when consumed in appropriate quantities, contribute positively to the host's health. Natural sources of probiotics include fermented millet products, which are recommended for managing diarrhea in young children. In Africa, fermented millet porridge and drinks such ad millet *kodo* are commonly consumed. These products contain lactic acid, which further enhances their probiotic properties. Prebiotics, on the other hand, are non-digestible food components that selectively promote the growth and activity of specific bacteria in the colon, thereby benefiting the host. Millet grains exhibit prebiotic activity, promoting the proliferation of friendly bacteria crucial for improving digestion. Malting of millet induces significant beneficial biochemical changes in the grain, further enhancing its prebiotic properties.
3. Impart resistance to various diseases: Flavonoids found in millets serve as antioxidants and contribute to various functions within the body's immune system. Consistent intake of millet lowers the risk of diabetes. Phenolic compounds present in millets, such as alpha-glucosidase and pancreatic amylase, help reduce postprandial hyperglycemia by partially inhibiting the enzymatic breakdown of complex carbohydrates.[11] Celiac disease is an immune-related condition triggered by the consumption of gluten, posing challenges for individuals genetically predisposed to gluten intolerance, who struggle to tolerate even small amounts of gluten in their diet. Millets, being devoid of gluten, offer a favorable option for individuals with celiac disease and those sensitive to gluten, who often face difficulties with the gluten content present in wheat and other common cereal grains.[12]
4. In addition, millets contain compounds such as phenolic acids, tannins, and phytate, which are categorized as "antinutrients." Despite this classification, these antinutrients have been found to reduce the risk of breast and colon cancer in animal studies. Consequently, millet phenolics hold promise in potentially preventing the initiation and progression of cancer, as evidenced by in vitro studies.[13]
5. Solution to malnutrition: The World Health Organization characterizes malnutrition as a condition marked by inadequate, disproportionate, or excessive energy or nutrient consumption within the body.[14] A notable portion of the global population in developing nations, particularly children, pregnant or breastfeeding women, and adolescent girls, is grappling with malnutrition.[15] Adding various traditional millet-based dishes such as porridge, beverages, and bread to the mid-day meal menu can significantly improve the nutritional value and quality of the meals.[16] Incorporating these items ensures that young children receive essential nutrients daily, which is an effective approach to providing adequate nourishment during their formative years.

3. CONCLUSION

The adoption of Western food habits has resulted in the preference for rice and wheat, leading to unhealthy eating habits. The rising prevalence of consuming refined cereals and leading a sedentary lifestyle has further deteriorated the health conditions among the Indian population. However, millets offer a comprehensive solution to address these issues. Millets can be utilized in both traditional and innovative dishes. The increasing recognition of the nutraceutical properties of minor millets suggests that it would not be long before this crop and its diverse products become a staple in every person's daily diet.

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This manuscript does not require ethical approval as it is a review study.

8. CONFLICTS OF INTEREST

Nil.

9. DATA AVAILABILITY

This is an original manuscript and all data are available for only review purposes from the authors.

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Millets	Common name	Scientific name
pearl millets	*Bajra*	*Pennisetum glaucum*
Sorghum millets	*Jowar*	*Sorghum bicolor*
Finger millets	*Ragi*	*Eleusine coracana*
Proso millets	*Chena*	*Panicum miliaceum*
Foxtail millets	*Kangni*	*Setariaitalic*
Barnyard millets	*Sanwa*	*Echinochloacrusgalli*
Little millets	*Kutki*	*Panicum sumatrense*
Kodo millets	*Kodon*	*Paspalum scrobiculatum*