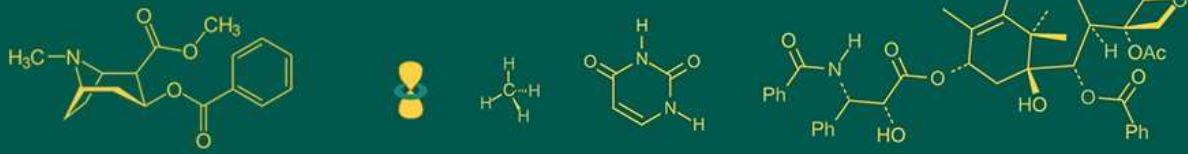


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## A sustainable nutriceal: A review on nutrient and bio-active composition and its potential health benefits of pearl millet

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### Abstract

Pearl millet (*Pennisetum glaucum*) stands out as a promising nutriceal, boasting a rich nutrient and bioactive profile that offers substantial health benefits. This comprehensive review examines the nutrient and bioactive composition of pearl millet and explores its potential health-promoting properties. Pearl millet is renowned for its high content of essential nutrients, including proteins, fibers, vitamins, and minerals, making it a valuable dietary staple in many regions. Additionally, pearl millet contains bioactive compounds such as phenolic compounds, flavonoids, and antioxidants, which contribute to its functional properties and potential health benefits. Evidence suggests that regular consumption of pearl millet may offer protective effects against chronic diseases such as diabetes, cardiovascular disorders, and certain cancers. Moreover, pearl millet exhibits a favorable glycemic index and gluten-free properties, making it suitable for individuals with specific dietary requirements. The review also discusses the culinary versatility and agronomic resilience of pearl millet, highlighting its potential role in promoting food security and sustainable agriculture. Overall, the findings underscore the nutritional significance and health-promoting potential of pearl millet, advocating for its inclusion in dietary recommendations and agricultural strategies aimed at enhancing human health and well-being.

**Keywords:** Parboiling, pearl millet, milling quality, physico-chemical composition

### Introduction

Pearl millet (*Pennisetum glaucum*) stands as an emblem of resilience and sustenance across diverse agricultural landscapes worldwide. As a staple crop in arid and semi-arid regions, pearl millet has been cultivated for centuries, providing sustenance and nutritional security to millions of people. Its robust nature, adaptability to harsh environments, and rich nutrient composition make it a cornerstone of food systems in regions where other crops struggle to thrive. In recent years, there has been a resurgence of interest in pearl millet driven by its remarkable nutritional profile and potential health benefits [1-2]. As the global population continues to expand, and environmental challenges intensify, the need for resilient and nutritious crops like pearl millet becomes increasingly evident. Understanding the nutrient composition, bioactive compounds, and potential health-promoting properties of pearl millet is essential for harnessing its full potential as a sustainable nutriceal [3]. The purpose of this review is to provide a comprehensive overview of the nutrient and bioactive composition of pearl millet and to explore its potential health benefits. We will delve into the rich nutritional content of pearl millet, including its protein, fiber, vitamin, and mineral content, highlighting its role as a valuable dietary component. Additionally, we will examine the presence of bioactive compounds such as phenolic compounds, flavonoids, and antioxidants in pearl millet, elucidating their potential health-promoting effects. Furthermore, this review will explore the evidence surrounding the health benefits of pearl millet consumption, including its impact on chronic disease prevention, glycemic control, and overall well-being. We will examine epidemiological studies, clinical trials, and experimental research to elucidate the physiological mechanisms underlying the health-promoting properties of pearl millet. Moreover, the introduction will touch upon the cultural significance and culinary versatility of pearl millet, showcasing its role in traditional cuisines and modern culinary innovations.

We will also discuss the agronomic resilience and environmental sustainability of pearl millet cultivation, emphasizing its potential to enhance food security and livelihoods in marginal agricultural regions, this review aims to shed light on the nutritional significance, health-promoting potential, and agronomic resilience of pearl millet as a sustainable nutriceal<sup>[4]</sup>. By synthesizing current research and exploring emerging trends, we hope to underscore the importance of pearl millet in promoting human health, ecological sustainability, and food security in a rapidly changing world. Superfoods are food commodities that are perceived to be extra nutrient-dense and favorable to health. The primary components of the Indian weight loss plan are cereal grains like rice and wheat. All-wheat and all rice-based diets are deficient in ample amounts of many minerals, dietary fibers, and antioxidants. About 820 million human beings globally face severe hunger. India has a global starvation index rating of 29.1 in 2022 and is positioned at 107th ranking out of 116 countries, indicating a towering stage of starvation in the area (WHO, 2022). Therefore, the agricultural production device ought to make challenging calls to mainstream the manufacturing of plants that are marginally grown in regions that have limited resources to overcome such a serious form of circumstance. Millets additionally contribute to reducing the effects of climate exchange because they have a decreased carbon footprint than wheat and rice, which have carbon dioxide footprints of 3.968kg and 3.401kg per hectare, respectively<sup>[5]</sup>. Malnutrition, the worst non-communicable condition, is an important contributor to the emergence of continual diseases. Due to insufficient nutritional intake of the recommended dietary allowance (RDA) level, malnutrition is significantly greater common among youngsters. The RDA is the naked minimum of nutrients required to preserve health. Pearl millet, a bountiful source of numerous micronutrients like iron, zinc, folic acid, and  $\beta$ -carotene, needs to be supplemented to the staple diets to fight malnutrition brought on by way of mineral deficiencies. Cereal grains are viewed as an effective source of energy in the human diet. Due to greater temperature tolerance and low preservation fee with dense nutrients, pearl millet attracts the cultivators as properly as researchers among all the cereal grain crops<sup>[6]</sup>. Millets are categorized into two classes as foremost millets which include proso millet (*Panicum miliaceum*), foxtail millet (*Setaria italica*), and pearl millet (*Pennisetum glaucum*). Among all the millets, pearl millet is the regular crop and is broadly grown in Asian and African regions<sup>[7]</sup>. Pearl millet can be grown under severe climatic conditions and is considered the primary fuel supply for the giant part of society present in the semi-arid tropical regions of Asia and Africa<sup>[7-8]</sup>.



Pearl Millet

### Nutritional and bioactive composition

The grains of pearl millet have higher protein, fibers, and strength ranges and accordingly are more nutritious than maize or sorghum<sup>[9]</sup>. In typical world millet production, India debts about 41% of the production and therefore serves as the greatest millet programmer all over the world (FAOSTAT, 2020) and it contributed nearly half of the percentile of the complete millet manufacturing in India<sup>[10]</sup>. Pearl millet is an important supply of zinc and iron which provides an affordable answer for fighting global starvation in terms of micronutrients<sup>[11-12]</sup>. Pearl millet is nutritionally equivalent to different renowned cereals, and its kernel is high in phytochemical and phenolic matter, making it a necessary feed and meal source. Moreover, they are natural free radical scavengers in meals and organic systems, which have fitness advantages and will be credibly effective in opposition to a variety of etiological conditions (Shahidi and Chandrasekara, 2013). Disseminate "nutri-cereals" all over the nation, the Indian government declared 2018 the "National Year of Millets" and introduced a millet campaign. The Integrated Child Development Services (ICDS) and MDM schemes across the kingdom will now comprise millets as a phase of a trial program these days set up by using NITI Aayog<sup>[13]</sup>. To reduce carbon emissions from the use of fossil fuels, Humble Prime Minister Shri Narendra Modi said in June 2021 that the goal of reaching 20% ethanol blending with fuel has been set up for 2025. In India, maize and sugar molasses are used in particular for the manufacturing of bioethanol. A study amongst farmers in Madhya Pradesh, however, verified that bio-ethanol may be generated by the usage of sorghum (jowar) and pearl millet (bajra), and that this fuel would possibly limit carbon emissions through approximately half.

### Nutritive value of pearl millet

The nutritive value of pearl millet (*Pennisetum glaucum*) makes it a valuable dietary staple, particularly in regions with challenging agroecological conditions. Here are some key aspects of the nutritive value of pearl millet:

- 1. Macronutrients:** Pearl millet is rich in macronutrients, including carbohydrates, proteins, and dietary fiber. It serves as an excellent source of energy due to its high carbohydrate content, making it a staple food in many diets. The protein content of pearl millet is comparable to that of other cereals, contributing to the dietary protein intake of individuals, especially in regions where access to animal protein is limited. Additionally, the dietary fiber content of pearl millet promotes digestive health and may help reduce the risk of chronic diseases such as cardiovascular disease and diabetes.
- 2. Micronutrients:** Pearl millet is a good source of essential micronutrients such as iron, zinc, magnesium, phosphorus, and B vitamins (including niacin, thiamine, and riboflavin). These micronutrients play vital roles in various physiological functions, including energy metabolism, immune function, and bone health. Incorporating pearl millet into the diet can help combat micronutrient deficiencies and promote overall health and well-being.
- 3. Antioxidants:** Pearl millet contains bioactive compounds such as phenolic acids, flavonoids, and tannins, which possess antioxidant properties. Antioxidants help protect cells from oxidative damage caused by free radicals and may reduce the risk of

chronic diseases such as cancer, cardiovascular disease, and neurodegenerative disorders. The antioxidant activity of pearl millet contributes to its health-promoting properties and underscores its potential as a functional food.

4. **Gluten-Free:** Pearl millet is naturally gluten-free, making it suitable for individuals with gluten intolerance or celiac disease. As the prevalence of gluten-related disorders increases, the demand for gluten-free alternatives in the diet is growing. Pearl millet serves as a nutritious and versatile grain option for individuals following gluten-free diets, providing essential nutrients without triggering adverse reactions.
5. **Glycemic Index:** Pearl millet has a relatively low glycemic index compared to other cereals, meaning it causes a slower and more gradual increase in blood sugar levels after consumption. This makes pearl millet particularly beneficial for individuals with diabetes or those aiming to manage blood sugar levels. The low glycemic index of pearl millet can help regulate appetite, promote satiety, and support weight management efforts, the nutritive value of pearl millet encompasses a wide range of macronutrients, micronutrients, antioxidants, and functional properties that contribute to its role as a sustainable and health-promoting food source. Incorporating pearl millet into diets can help address malnutrition, combat chronic diseases, and promote food security in diverse populations worldwide.

#### Potential health benefits of pearl millet

Epidemiological evidence from research has shown that diets rich in plant meals are defensive against various degenerative illnesses such as cancer, cardiovascular ailments, diabetes, metabolic syndrome, and Parkinson's ailment [14-15].

Milletts have to also be every day as purposeful food and nutraceuticals because they provide dietary fibers, proteins, energy, minerals, vitamins, and antioxidants required for human health. Several plausible fitness benefits such as stopping cancer and cardiovascular diseases, decreasing tumor incidence, decreasing blood pressure, risk of coronary heart disease, cholesterol, and the fee of fats absorption, delaying gastric emptying, and supplying gastrointestinal bulk had been suggested for millets [16-49]. Pearl millet, a highly nutritious and versatile grain, offers a multitude of potential health benefits that make it a valuable addition to diets worldwide. Rich in essential nutrients and bioactive compounds, pearl millet has gained recognition for its role in promoting overall health and well-being.

One of the standout features of pearl millet is its impressive nutritional profile. It is a rich source of complex carbohydrates, dietary fiber, and protein, making it a sustaining and satiating food choice. The high fiber content in pearl millet supports digestive health by promoting regular bowel movements, preventing constipation, and reducing the risk of gastrointestinal disorders such as diverticulosis. Moreover, the slow digestion of complex carbohydrates in pearl millet helps regulate blood sugar levels, making it an ideal choice for individuals managing diabetes or insulin resistance. Furthermore, pearl millet is a powerhouse of essential vitamins and minerals. It is particularly rich in iron, magnesium, phosphorus, and potassium, all of which play critical roles in maintaining

optimal health. Iron is essential for the production of hemoglobin and red blood cells, helping prevent anemia and fatigue. Magnesium supports bone health, muscle function, and nerve transmission, while phosphorus contributes to bone strength and energy metabolism. Potassium helps regulate blood pressure, fluid balance, and heart function, reducing the risk of hypertension and cardiovascular disease. In addition to its nutritional composition, pearl millet contains a variety of bioactive compounds with potential health-promoting properties. It is a good source of antioxidants, including phenolic compounds, flavonoids, and carotenoids, which help neutralize harmful free radicals, reduce oxidative stress, and protect against chronic diseases such as cancer, heart disease, and aging-related conditions. The presence of phytochemicals like lignans and phytosterols in pearl millet may also confer anti-inflammatory, anti-cancer, and immune-enhancing effects, further contributing to its overall health benefits.

Pearl millet's gluten-free status makes it a suitable alternative for individuals with celiac disease or gluten intolerance, offering a nutritious grain option without triggering adverse reactions. Its low glycemic index (GI) and gluten-free nature also make it an excellent choice for individuals seeking weight management and blood sugar control. Moreover, pearl millet's versatility in culinary applications makes it adaptable to various cuisines and dishes, ranging from porridges, bread, and cakes to savory pilafs, salads, and stews. Its mild flavor profile and chewy texture make it a versatile ingredient in both sweet and savory recipes, allowing for creative culinary exploration while reaping its health benefits., pearl millet stands out as a nutrient-dense, gluten-free grain with numerous potential health benefits. Its rich array of essential nutrients, antioxidants, and bioactive compounds make it a valuable addition to balanced diets, supporting digestive health, blood sugar control, heart health, bone strength, and overall well-being. With its culinary versatility and nutritional prowess, pearl millet offers a wholesome and delicious option for promoting health and vitality. Pearl millet, a staple crop in many parts of the world, holds significant potential for enhancing human health due to its rich nutritional composition and various health-promoting properties. Here are some potential health benefits associated with consuming pearl millet:

1. **Nutrient Density:** Pearl millet is a rich source of essential nutrients, including carbohydrates, proteins, dietary fiber, vitamins, and minerals. It provides an excellent source of energy and sustenance, making it a valuable dietary component for individuals of all ages, especially in regions where food security is a concern.
2. **High in Protein:** Pearl millet contains a notable amount of protein, making it a valuable plant-based protein source, particularly for vegetarians and vegans. Protein is essential for muscle repair and growth, immune function, hormone production, and overall cellular health.
3. **Rich in Dietary Fiber:** Pearl millet is high in dietary fiber, including both soluble and insoluble fiber. Dietary fiber promotes digestive health by preventing constipation, regulating bowel movements, and supporting a healthy gut microbiome. It can also help lower cholesterol levels, stabilize blood sugar levels, and reduce the risk of chronic diseases such as diabetes and heart disease.

4. **Gluten-Free:** Pearl millet is naturally gluten-free, making it a suitable grain option for individuals with celiac disease or gluten sensitivity. It provides a safe and nutritious alternative to gluten-containing grains like wheat, barley, and rye.
5. **Low Glycemic Index:** Foods with a low glycemic index (GI) are digested and absorbed slowly, leading to gradual increases in blood sugar levels. Pearl millet has a low GI, which can help stabilize blood sugar levels and prevent spikes and crashes, making it a suitable choice for individuals with diabetes or those looking to manage their blood sugar levels.
6. **Rich in Antioxidants:** Pearl millet contains various antioxidants, including phenolic compounds, flavonoids, and carotenoids. These antioxidants help neutralize harmful free radicals in the body, reduce oxidative stress, and protect against chronic diseases such as cancer, heart disease, and neurodegenerative disorders.
7. **Heart Health:** The magnesium and potassium content in pearl millet supports heart health by helping regulate blood pressure, maintaining proper heart rhythm, and reducing the risk of cardiovascular diseases such as hypertension and stroke.
8. **Weight Management:** Pearl millet's high fiber content and low energy density make it a filling and satisfying food choice, which can help promote satiety, reduce overall calorie intake, and support weight management goals. In summary, pearl millet offers a plethora of potential health benefits due to its nutrient-rich composition, gluten-free nature, low glycemic index, and antioxidant properties. Incorporating pearl millet into a balanced diet can contribute to overall health, well-being, and disease prevention, making it a valuable addition to diverse culinary traditions and dietary patterns worldwide.

### Conclusion

Pearl millet is a nutritious but underutilized grain crop used as standard food education by humans of decreased financial strata. It is known as "pearl millet". It is not expensive like pearl however it sincerely has pearl first-rate which is recommended to the body. one hundred grams of bajra has the following dietary values: energy 360 calories, moisture 12g, protein 12g, fat 5g, mineral 2g, fiber 1 g, carbohydrate 67g, Calcium 42mg, phosphorus 242mg, and iron 8mg. Therefore, with value-added techniques and fantastic processing technologies, millet grains can locate a vicinity in the coaching of countless value-added and health food products, which may additionally then end result in excessive demand from massive urban populations and nontraditional millet users Dieticians and nutritionists are attempting their fantastic to educate about plausible fitness advantages among all agencies of humans and promote this particular millet with the aid of amplifying its consumption. Awareness amongst the people helps to create a fantastic attitude closer to this millet. Due to the abundance of necessary vitamins in ample portions and of high quality, which are required for main a healthful and nutrient-rich life, bajra or pearl millet is also famed as the "powerhouse of nutrition." Elevated concentrations of micronutrients and macronutrients like iron, zinc, magnesium, calcium, phosphorus, copper, manganese, riboflavin, and folic acid can be observed in pearl millet. It is becoming famous and

preferred employing human beings all across the world, particularly in developed nations, as a final result of its tremendous dietary properties. The value of millet is apparent from its linkage to the food security, nutrition, and poverty eradication sustainable development goals (SDGs). Millets along with pearl millet may want to be employed in interventions in India's sustainability practices. Technological breakthroughs in the study have clarified millets' implications for energy optimization, climate resilience, and ecosystem restoration.

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