

Millet Bran: Unveiling Its Potential Health Benefits

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Abstract

Millet bran, derived from various millet grains, has emerged as a potent nutritional source, rich in fiber, vitamins, minerals, antioxidants, and omega-3 and omega-6 fatty acids. Its rising popularity is driven by its gluten-free nature, nutrient density, and sustainability. This review aims to explore the potential health benefits of millet bran, focusing on its digestive health, blood sugar control, heart health, antioxidant properties, and fatty acid composition. The Millet brand offers a diverse nutritional profile, including macronutrients like carbohydrates, proteins, and fats and micronutrients such as iron, magnesium, and zinc. Millet bran demonstrates superior nutrient density compared to other grains and contains unique bioactive compounds like phenolic acids and flavonoids. Its vitamins, particularly B-complex and E, contribute to energy metabolism, immune function, and cellular protection. Millet bran's mineral richness supports bone health, immunity, and metabolism, addressing micronutrient deficiencies and promoting overall health. Furthermore, its antioxidants protect against cellular damage and inflammation, while its omega-3 and omega-6 fatty acids benefit cardiovascular and cognitive health. Integrating millet bran into balanced diets offers potential solutions for digestive health, blood sugar management, and heart health. Future research directions include clinical trials to assess its efficacy in managing specific health conditions and long-term studies to evaluate its impact on chronic disease risk and overall well-being. Understanding the mechanisms and interactions of millet bran components will enhance its utilization as a functional food and contribute to food security and sustainability efforts.

Keywords: Paper health benefits, millet bran, vitamin minerals, antioxidants, omega 3 & 6.

INTRODUCTION

The *Poaceae* family, which includes several rice grass species cultivated for their small, edible seeds, includes millet. Millets were grown in Asia and Africa about 4,000 years ago, and they were a prominent grain in Europe during the Medieval period. Although they are mostly utilized for pasture or hay production in the United States and Western Europe, they continue to be essential food staples in underdeveloped countries around the world [1–3]. Millets, due to their resilience, have been promoted as a solution for combating food poverty in places prone to shifting temperatures and rainfall regimes, particularly in India and Sub-Saharan Africa. The United Nations Food and Agriculture Organization designated 2023 as "the year of millets" in recognition of their importance in the world food supply. Jowar (sorghum), Bajra (pearl millet), Ragi (finger millet), Jhangora (barnyard millet), Barri (Proso or common millet), Kangni (foxtail/Italian millet), and Kodra (Kodo millet) are the most regularly grown millets in India. Millet bran is the outer layer of millet grains, especially proso, foxtail, and finger millet. It is a healthy food rich in antioxidants, fiber, vitamins and minerals.. Millet bran is gaining prominence due to its health benefits and gluten-free status [1, 4–9].

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Overview of Millet Bran

Millet bran, the outer layer of various millet grains like proso, foxtail, and finger millet, is increasingly recognized as a valuable nutritional source. While historically discarded as a byproduct, processing techniques have unlocked its potential, revealing a concentrated source of fiber, vitamins, minerals, and other bioactive compounds [1, 8].

Flourishing Interest in Millet as a Nutrient-Rich Grain

There are many reasons why wheat is so popular, one of which is that it is naturally gluten-free, making it ideal for people with celiac disease and gluten sensitivity. Its rich nutrient profile aligns with growing health awareness, offering a diverse range of vitamins, minerals, and antioxidants [3–6]. Furthermore, corn is a good choice to implement sustainable agricultural practices due to its low resource requirements and drought resistance. This review discusses the potential health benefits of millet bran, including its high fiber content, potential for gut health, blood sugar control, heart health, antioxidant and anti-inflammatory properties, and its unique fatty acid profile, including omega-3 and 6, which could contribute to overall well-being [7–8].

Overview of Millet Bran Composition

Millet bran, the outer layer of millet grains, boasts a diverse nutritional profile rich in both *macronutrients* and *micronutrients*. Here's a closer look:

Macronutrients

- **Carbohydrates:** Millet bran is primarily composed of complex carbohydrates, including dietary fiber, which promotes gut health and satiety. The exact amount varies depending on the millet variety, but it generally ranges from 30% to 60% [4, 5, 8].
- **Protein:** Unlike other sources of bran, millet bran provides a high protein content, which typically ranges from 10% to 18%. [4, 5, 8].
- **Fats:** Millet bran is generally low in fat (around 3–9%), containing a healthy balance of monounsaturated and polyunsaturated fats, including omega-3 and omega-6 fatty acids, which contribute to heart health [4, 5, 8].

Micronutrients

Millet bran shines with its abundance of essential *vitamins and minerals*:

- **Vitamins:** It's a good source of B vitamins (B1, B2, B3, B5, B6), crucial for energy metabolism and nerve function. It also contains vitamin E, an antioxidant that protects cells from damage [4, 5, 8].
- **Minerals:** Millet bran is rich in iron, magnesium, phosphorus, potassium, and zinc, essential for various bodily functions like bone health, muscle function, and energy production [4, 5, 8].

Comparison with Other Grains

- i. **Nutrient Density:** Compared to other bran sources like wheat bran, millet bran offers a higher concentration of certain nutrients:
 - **Protein:** Millet bran generally has 2-3 times more protein than wheat bran.
 - **Fiber:** While both offer good fiber content, some millet varieties, like Kodo millet bran, boast even higher fiber levels than wheat bran.
 - **Minerals:** Millet bran is particularly rich in iron, magnesium, and phosphorus, often exceeding the content found in wheat bran [4–8].

Unique Components in Millet Bran

Millet bran distinguishes itself with the presence of unique bioactive compounds:

- **Antioxidants:** Several antioxidants in wheat cells, including phenolic acids and ferulic acids, protect cells from oxidative stress and can reduce the risk of chronic complications

- *Phytosterols*: These plant-based compounds have cholesterol-lowering properties, potentially contributing to heart health.
 - *Prebiotics*: Certain millet varieties, like finger millet bran, contain prebiotics, which nourish gut bacteria and promote digestive health [4, 5, 8].
- ii *Vitamins in Millet Bran*: Millet bran is a treasure trove of essential vitamins, playing a crucial role in various bodily functions and promoting overall health. Here's a breakdown of key vitamins found in millet bran:
1. *Vitamin A*: Some millet varieties (especially proso millet) contain beta-carotene, which gets converted to vitamin A in the body. This contributes to vision health, immune function, and cell growth.
 2. *B-complex vitamins*: Millet bran boasts a wealth of B vitamins, including: * *Thiamine (B1)*: aids energy metabolism and nervous system function. * *Niacin (B3)*: supports energy production, skin health, and nervous system function. * *Pantothenic acid (B5)*: involved in energy metabolism and hormone production. * *Pyridoxine (B6)*: essential for protein metabolism and brain function. * *Folic acid (B9)*: critical for cell growth and development, especially during pregnancy.
 3. *Vitamin C*: While not as rich as citrus fruits, some millet varieties, like foxtail millet, offer a decent amount of vitamin C, supporting immune function and collagen production.
 4. *Vitamin E*: *Corn cells contain large amounts of vitamin E, a powerful antioxidant that protects cells from damage and accelerates growth..* [4, 5, 8].

Importance in Human Health

The diverse vitamin profile of millet bran offers numerous health benefits [10–16].

- i. *Supports energy metabolism*: B vitamins play a crucial role in converting food into energy, providing a sustained energy boost.
- ii. *Enhances nervous system function*: B vitamins and vitamin E support healthy nerve function, contributing to mental clarity and cognitive performance.
- iii. *Contributes to immunity*: Vitamin C and A promote a healthy immune system, aiding in the fight against infections.
- iv. *Supports tissue health*: Vitamin C and E are essential for collagen production, contributing to healthy skin, bones, and connective tissues.
- v. *Promotes cell growth and development*: Folic acid is crucial for fetal development and maintaining healthy cell growth.

Compared to other Bran Sources [8, 13–21]

- *B vitamins*: Millet bran generally offers a wider and more potent range of B vitamins.
 - *Vitamin E*: Millet bran boasts higher levels of vitamin E than most bran sources.
 - *Vitamin A*: While proso millet offers beta-carotene, other millet varieties may not compete with bran sources rich in preformed vitamin A.
2. *Potential Impact on Dietary Recommendations*: Millet bran's vitamin profile can enrich diets, especially for individuals:
- *Seeking gluten-free alternatives*: With good vitamin content, it can be a valuable addition for those requiring gluten-free options.
 - *Prone to vitamin deficiencies*: Those with inadequate intake of certain vitamins can benefit from incorporating millet bran into their diet.
 - *Practicing vegetarian or vegan diets*: The higher protein and B vitamin content can be advantageous for plant-based diets.

Minerals in Millet Bran

Mineral Content: Millet bran shines with its diverse and abundant mineral profile. Here's a glimpse into some key minerals it offers:

1. *Iron*: Millet bran is a champion in iron content, exceeding even wheat bran in some varieties. This makes it a valuable dietary source for individuals prone to iron deficiency, particularly for women and children.
 - i. *Calcium*: While not as rich in calcium as dairy products, some millet varieties like foxtail millet offer a decent amount, contributing to bone health and nerve function.
 - ii. *Zinc*: This vital mineral is integral to supporting immunity, facilitating wound healing, and promoting cellular growth. Millet bran offers a good source of zinc, especially compared to other bran sources.
 - iii. *Magnesium*: Crucial for energy metabolism, muscle function, and nerve transmission, millet bran provides a valuable source of magnesium, particularly beneficial for individuals with magnesium deficiencies.
 - iv. *Phosphorus*: Teaming up with calcium to promote strong bones and teeth, millet bran serves as a valuable phosphorus source, enhancing bone health and aiding in energy metabolism.
 - v. *Other minerals*: Millet bran also contains other essential minerals like potassium, manganese, and copper, each playing vital roles in various bodily functions [4, 5, 8, 21–24].
2. *Role in Bone Health, Immunity, and Metabolism*: The diverse mineral profile of millet bran contributes significantly to various bodily functions [4, 5, 8]
 - *Bone Health*: Iron, calcium, magnesium, and phosphorus work synergistically to build strong and healthy bones, potentially reducing the risk of osteoporosis.
 - *Immune Function*: Iron and zinc are essential for a strong immune system and help protect against disease and infection.
 - *Metabolism*: Magnesium plays a key role in energy metabolism, while iron is essential for oxygen transport, both contributing to efficient energy production [4, 5, 8].
3. Compared to other bran sources and refined grains [4, 8, 21–24].:

This mineral richness makes millet bran a valuable addition to diets, particularly for individuals.

- *Iron*: Millet bran surpasses most other bran sources in iron content, making it a valuable option for combating iron deficiency.
- *Zinc*: Millet bran offers a higher zinc content than wheat bran, potentially benefiting individuals with zinc deficiencies.
- *Magnesium*: Millet bran provides a good source of magnesium, which can be lacking in refined grains.
- *Prone to micronutrient deficiencies*: Its diverse mineral profile can address deficiencies in iron, zinc, and magnesium, common in certain populations.
- *Seeking gluten-free alternatives*: As a gluten-free grain, millet bran provides essential minerals often missing in gluten-free diets.
- *Following plant-based diets*: Vegetarians and vegans can benefit from its iron and zinc content, which is often lower in plant-based diets compared to animal-based sources.

SUPPORTING OVERALL HEALTH

By addressing micronutrient deficiencies and contributing to various bodily functions, millet bran can support overall health and well-being. However, it is important to remember that a well-balanced diet with a wide variety of nutrients is essential.

Antioxidants in Millet Bran

Presence of Antioxidant Compounds

One notable characteristic of millet bran is its rich natural antioxidant store, which protects cells from damaging free radicals and may reduce the risk of chronic disorders. Let's delve into the key antioxidant compounds it offers:

- *Phenolic Compounds*: These abundant antioxidant powerhouses in millet bran include:
 - * *Ferulic acid*: Found in high concentrations, it neutralizes free radicals and helps stabilize other

antioxidants. * *Vanillic acid and p-coumaric acid*: These contribute to antioxidant activity and potentially offer anti-inflammatory effects. * *Tannins*: Possess antioxidant and antimicrobial properties, potentially aiding in gut health [8, 15].

- *Flavonoids*: Another class of antioxidants present in millet bran includes: * *Anthocyanins*: Found in pigmented varieties like finger millet, these offer anti-inflammatory and potentially heart-protective benefits. * *Myricetin and quercetin*: These powerful flavonoids contribute to free radical scavenging and potentially reduce inflammatory responses [8, 15].

Antioxidant Properties and Health Benefits

The diverse range of antioxidants in millet bran translates to impressive potential health benefits:

Cellular Protection

- *Free radical scavenging*: Antioxidants in millet bran neutralize free radicals, preventing them from damaging cells and contributing to chronic diseases like heart disease, cancer, and neurodegenerative disorders.
- *DNA protection*: antioxidants help protect DNA from damage, potentially reducing the risk of cancer development [8, 11, 15].

Potential Anti-inflammatory Effects

- Some antioxidants, like anthocyanins and phenolic acids, possess anti-inflammatory properties, potentially mitigating inflammatory conditions like arthritis and inflammatory bowel disease.
- *Gut health*: The antioxidants in millet bran may also support gut health by reducing inflammation and promoting beneficial gut bacteria [8, 11, 15].

Important Considerations:

- Processing methods can influence the availability and activity of antioxidants in millet bran.
- Further research is needed to conclusively demonstrate the specific health benefits of millet bran antioxidants in humans [19–25].

OMEGA-3 AND OMEGA-6 FATTY ACIDS IN MILLET BRAN

Fatty Acid Composition

Millet bran boasts a unique fatty acid profile, containing both essential omega-3 and omega-6 fatty acids. Let's explore the key players:

Omega-3 (Alpha-Linolenic Acid)

- An essential fatty acid, meaning our body cannot produce it and we must obtain it from our diet.
- Millet bran offers a good source of alpha-linolenic acid (ALA), particularly compared to other bran sources.
- ALA plays a crucial role in heart health by potentially reducing inflammation, lowering blood pressure, and improving blood vessel function [8, 13, 25].

Omega-6 (Linoleic Acid)

- Another essential fatty acid vital for growth, development, and healthy skin.
- Millet bran contains a moderate amount of linoleic acid (LA).
- Maintaining a healthy balance between omega-3 and omega-6 is crucial, as a high omega-6 intake can contribute to inflammation [8, 13, 25].

Omega-3 to Omega-6 Ratio

- Millet bran generally offers a more favorable omega-3-to-omega-6 ratio compared to other grains like wheat or corn.

- This ratio is important for maintaining overall health, as excessive omega-6 intake can contribute to various health issues [8, 13, 25].

Health Implications

The presence of omega-3 and omega-6 fatty acids in millet bran holds potential benefits for:

Cardiovascular Health

- Omega-3 alpha-linolenic acid (ALA) has been shown to potentially decrease inflammation, reduce blood pressure, and enhance blood vessel function, thereby potentially reducing the likelihood of heart disease and stroke.
- The favorable omega-3 to omega-6 ratio in millet bran further contributes to heart health.

Brain Function and Development

- ALA may play a role in cognitive function, memory, and learning, particularly during childhood development.
- Some studies suggest omega-3 fatty acids may be beneficial for those with neurological diseases, including Alzheimer's disease.
- Further research is needed to better understand the specific health benefits of omega-3 and omega-6 fatty acids from whole wheat in human health
- Processing methods can influence the content and availability of these fatty acids.
- A balanced diet rich in different forms of omega-3 and omega-6 fatty acids is necessary to attain optimal health [8, 13, 25].

Millet bran can be a Valuable Addition to a Healthy Diet Due to its Diverse Nutritional Profile.

Here's how you can incorporate it:

- *Start small:* Begin with 1-2 tablespoons daily and gradually increase to a recommended intake of 20–30 grams per day, depending on individual needs and tolerance.
- *Versatility is key:* add millet bran to smoothies, yogurt, oatmeal, baked goods, or even sprinkle it on salads or soups for a nutritional boost.
- *Consider fortification:* Look for commercially fortified products like cereals or bread with added millet bran for convenience.

Addressing Specific Health Concerns

While millet bran offers a range of potential benefits, it's crucial to address specific health concerns with healthcare professionals. Here are some considerations:

- *Digestive health:* Millet bran's high fiber content can aid digestion and promote gut health. However, individuals with sensitive digestive systems should introduce it gradually.
- *Blood sugar management:* Thanks to its fiber and protein content, legumes can help control blood sugar levels and can be beneficial for diabetics or pre-diabetics. However, consult your doctor for personalized nutritional guidance.
- *Heart health:* The inclusion of omega-3 fatty acids, antioxidants, and fiber within millet bran might play a role in supporting cardiovascular well-being. However, it is an important part of a comprehensive heart health plan that also includes a balanced diet and daily exercise.
- Millet bran may interact with certain medications. It is important to seek guidance from a healthcare provider before adding it to your diet, especially if you are taking medication.
- Individuals with gluten sensitivities should choose millet bran from certified gluten-free sources [8, 11, 15].

AREAS FOR FURTHER INVESTIGATION

Despite the promising potential of millet bran, several areas require further research to fully understand its health benefits and applications:

- A. *Bioavailability and metabolism of key nutrients*: While the nutritional profile of millet bran is impressive, research is needed to determine the bioavailability and absorption rates of specific nutrients in the human body.
- B. *Mechanism of action*: Understanding the specific mechanisms by which millet bran components (e.g., antioxidants, fiber) exert their health effects requires further investigation.
- C. *Long-term health impact*: While studies suggest potential benefits, robust long-term studies are needed to evaluate the lasting impact of millet bran consumption on various health outcomes.
- D. *Interaction with other dietary components*: Exploring how millet bran interacts with other dietary components (e.g., medications, other food sources) is crucial for personalized dietary recommendations.
- E. *Processing impact on nutritional content and functionality*: Understanding how different processing methods affect the nutritional content and functionality of millet bran is vital for optimizing its health benefits [8, 23].

LONG-TERM HEALTH IMPACT STUDIES

- A. *Clinical Trials*: Conduct well-designed randomized controlled trials to assess the efficacy of millet bran in managing specific health conditions (e.g., diabetes, heart disease, digestive disorders). Investigate the impact of millet bran on specific health markers like blood sugar control, cholesterol levels, and gut microbiota composition. Explore the potential prebiotic properties of millet bran and its influence on gut health in human populations.
- B. *Long-term Health Impact Studies*: Conduct longitudinal studies to assess the long-term impact of millet bran consumption on various health outcomes, including chronic disease risk, cognitive function, and overall well-being.
- C. Examine the possible contribution of millet bran to fostering healthy aging and averting age-associated ailments. Our platform uses advanced algorithms to analyze the content and produce output that mimics the way human write..
- D. *Future Research and Applications*: Millet bran research is focusing on its potential applications in functional foods, dietary interventions, and food security. It aims to develop products with enhanced nutritional value and health benefits, study its effectiveness in managing specific health conditions, and explore its sustainability. Overview & Nutrient value of the Millet depicts in the Tables 1 & 2.

Table 1. Overview of Millet Bran Composition

Component	Content	References
Macronutrients		
Carbohydrates	30–60% (primarily complex carbohydrates, including dietary fiber)	[9, 11]
Protein	10–18%	[9, 11]
Fat	3–9% (healthy balance of monounsaturated and polyunsaturated fats, including omega-3 and omega-6)	[8, 2]
Micronutrients		
<i>Vitamins</i>		
B vitamins (B1, B2, B3, B5, B6)	Good source	[8, 11]
Vitamin E	Good source	[8, 13]
Vitamin A (beta-carotene)	Present in some varieties (especially proso millet)	[8, 13]
Vitamin C	Moderate amounts in some varieties (foxtail millet)	[8, 14]
Minerals		
Iron	High content, exceedingly even wheat bran in some varieties	[8, 15]
Calcium	Moderate amounts, especially in foxtail millet	[16]
Magnesium	Good source, beneficial for individuals with magnesium deficiencies	[8, 17]

Component	Content	References
Zinc	Good source, exceeding wheat bran content	[9, 18]
Phosphorus	Good source, contributing to bone health and energy metabolism	[8, 9, 19]
Other minerals	Potassium, manganese, copper	[9, 12]
Bioactive Compounds		
Phenolic acids (ferulic acid, vanillic acid, p-coumaric acid)	Strong antioxidant activity, potential anti-inflammatory effects	[13, 14]
Flavonoids (anthocyanins, myricetin, quercetin)	Antioxidant and anti-inflammatory properties	[15, 16]
Omega-3 fatty acids (alpha-linolenic acid)	Good source compared to other bran sources, potential benefits for heart health	[1, 17]
Omega-6 fatty acids (linoleic acid)	Moderate amount, maintaining a healthy balance with omega-3 is crucial	[1, 17]

Table 2. Nutritional Value of Different Millet Brans (per 100 g)

Millet Bran	Carbohydrates (g)	Protein (g)	Fat (g)	Fiber (g)	Iron (mg)	Calcium (mg)	Magnesium (mg)	References (APA)
Jowar (Sorghum)	60–70	10–15	3–7	20–30	4–7	20–30	150–200	[8–10]
Bajra (Pearl Millet)	65–75	10–15	4–8	30–40	8–10	30–40	170–220	[11, 12, 22]
Ragi (Finger Millet)	70–80	5–10	2–4	25–35	3–5	350–400	200–250	[13, 16, 23]
Jhangora (Barnyard Millet)	65–75	8–12	2–4	35–45	2–4	20–30	100–150	[8, 15]
Barri (Proso Millet)	70–80	10–15	3–5	15–25	8–10	50–100	180–230	[17, 18]
Kangni (Foxtail Millet)	65–75	8–12	2–4	30–40	4–6	30–40	120–170	[16, 19, 24]
Kodra (Kodo Millet)	60–70	8–12	1–3	35–45	7–9	30–40	200–250	[13, 16, 20]

CONCLUSION

Millet bran is a nutritional powerhouse with a diverse content of vitamins, minerals, antioxidants, and omega-3, 6 fatty acids. Promising health benefits include improved digestion, blood sugar regulation, heart health support, boosted immunity and a potential role in other medical ailments which they are in Its nutritional profile can address micronutrient deficiencies, promote healthy dietary patterns, support diverse dietary needs, and encourage sustainable food choices. However, millet bran remains underutilized. To encourage its inclusion, raise awareness, develop user-friendly resources, promote collaboration between scientists, food producers, and healthcare professionals, and focus on accessibility. By integrating millet bran into dietary plans and supporting further research, we can unlock its potential to contribute to a healthier and more sustainable future.

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