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Nutritional Benefits of Millets in Early Childhood: A Review

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ABSTRACT

This study investigates the nutritional benefits of including millets in children's meals. Millets, a class of small-seeded grains, has drawn interest due to their abundant nutrient content, rich in essential vitamins, minerals and dietary fibers. The major types of millets are, finger millet, pearl millet, Foxtail millet, Porso or white millet. They have become nutritional powerhouses due to their high quantities of phytochemicals and micronutrients which strengthens the body's immune system. Millets provide high energy and nourishment required in the early stages of child development over other cereals. The major concern of low bioavailability of minerals like iron, calcium and zinc in common cereal-based foods such as rice and wheat, can be fulfilled by millets. The body of research summarizes on how eating millet affects young children's growth, cognitive development and general health. Through a systematic examination of studies undertaken in varied settings, this review elaborates the contribution of millets in treating nutritional inadequacies and supporting optimal well-being in this vital stage of early childhood. The review aims to provide practical insights for mothers and caregivers, to enhance the nutritional quality of diets for children. The results highlight millet's potential as a beneficial dietary element and information for improvising young children's nutritional environment.

Key words: Children's health benefits, Dietary elements, Micronutrients, Millets.

Millets are referred to as "the nutri-cereals of today and the coarse grains of yesterday" (Kheya, 2023). Additionally, as a result of their resistance to pests and illnesses, millets flourish in the difficult conditions in cetain regions of Asia and Africa. Due to this resillience, they are also called "future crops" (Anitha, 2023).

Millets were once widely consumed in India (Sukumaran and Asha Devi, 2023), but in the 1960s, the Green Revolution's emphasis on food security caused millets to become "orphan crops," meaning they were rarely eaten and virtually forgotten. Millets accounted for around 40% of all cultivated grains before the Green Revolution; over time, this percentage has decreased to about 20% (Chari *et al*., 2016). Not only have millets become less popular, but commercial crops like oilseeds, pulses and maize have taken the position of millets in the producing region. These commercial crops are profitable and various policies, such as subsidized inputs, procurement incentives and Public Distribution System inclusion, support their production. As a result, dietary trends have changed with a preference for fine-grain cereals that are high in calories (Nithiyanantham *et al*., 2019).

Millets are grains, that can often be used as food. The most common ones are sorghum (*Sorghum bicolor* L.), pearl millet (*Pennisetum glaucum*), finger millet (*Eleusine carocana*), teff (*Eragrostis tef*), proso millet (*Panicum miliaceum*), kodo millet (*Paspalum scrobiculatum*), foxtail millet (*Setaria italica*), little millet (*Panicum sumatrense*) and fonio (*Digitaris exilis*) (Nithiyanantham *et al.*, 2019).

This review intends to promote awareness and further research into the potential of millets as a useful dietary resource for promoting optimal health and development in early childhood by combining diverse findings.

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Millet cultivation and Incorporation of Millets in Indian Household Meals

Sorghum, Pearl millet, Finger millet and small millets such as Barnyard millet, Proso millet, Kodo millet, Little (Kutki) millet and Foxtail millet are among the varietal millets cultivated in India. India is the world's largest producer of millets (Zhang *et al*., 2009). In the past, millets accounted for nearly the same amount of land coverage as wheat and rice and were widely produced and consumed in the nation. Despite its many uses and advantages, the area dedicated to the production of nutri-cereals had a sharp decrease in the post-green revolution era, falling by 41.65 per cent between 1950-1951 and 2018-19. Low compensation relative to other food crops, a lack of price incentives and input subsidies, subsidized supply of flour through the Public Distribution System (PDS), a shift in consumer preferences as a result of processing difficulty, low flour shelf life and low social status associated with millets and the emphasis placed on rice and wheat during the green revolution are the main causes of this decline, according to reports (Sreekala and Devi, 2023).

Millets were among the first foods that humans are known to have consumed, but their importance and cultivation have decreased because of industrialization, urbanization and large-scale wheat and rice production. Millets have started gaining popularity again due to its high nutritional content leading to benefits like reducing the risk of lifestyle disorders like diabetes, hypertension and cardiovascular disease (Hou and Chen, 2018).

Millets are an important part of traditional meals in rural India since they provide a wholesome and enduring source of food (Divya and Garg, 2024). Millets function as the main source of carbohydrates and are frequently eaten in the form of traditional recipes like ragi mudde and bhakri. These grains are also used in several regional dishes like jowar roti and bajra khichdi. Because of their adaptability, millets can also be used to increase the nutritional diversity of porridges. They are also ideally suited for farming in rural locations due to its resistance to harsh weather, which helps to provide food security. Special delicacies like foxtail millet payasam, are cooked during local events, which showcase the cultural significance of millets. Adopting millets supports sustainable farming methods in rural areas while also protecting culinary legacy.

Millets are incorporated into culinary customs across India's many rural landscapes, representing local inclinations and tastes. Pearl millet, or bajra, is used in famous meals like bajra khichdi in the northern state of Punjab, where it enhances the bold flavours of the area. Moving on to West Bengal, the addition of kodo millet to fried meals like bhaja and sweet dumplings like pithe gives traditional Bengali food a distinct flavour.

Famous finger millet (ragi) mudde is a staple in the southern state of Karnataka, usually served with spicy lentil soup or tart stew, huli. Tamil Nadu is known for its love of kambu, or pearl millet, which is used in dishes like the nutritious millet rice meal kambu sadam and the pleasant, fermented drink kambu koozh. Kerala, on the southwest coast, makes puttu, a steamed cylindrical cake with grated coconut and banana, using barnyard millet. Jowar (sorghum) roti is a staple food in the western state of Maharashtra. It's typically eaten with pithla (gramme flour curry) or bhakri. Now let's head to the desert plains of Rajasthan, where bajra is the star of the famous "bajre ki roti," a thick unleavened bread that is eaten with jaggery or ghee.

Traditionally, "joba bhutia" and other traditional recipes in the northeastern state of Assam feature Job's tears, or "joba," which lends a unique flavor.

All things considered, millets in rural India represent a diverse range of culinary styles, supporting both regional cuisines and sustainable agricultural methods. As a result, to better understand this prevalence of millets in cuisines throughout India, it is important to consider their nutritional benefits as listed in Table 1.

In addition to their high protein, fibre, minerals contents and low gluten content, millets are rich in amino acids which are essential for protein synthesis. This makes millets a superfood. Table 2 lists the amino acids content in different types of millets.

Millets offer numerous nutritional benefits for children, contributing to their overall growth and development (Ambati and Sucharitha, 2019)

Rich in nutrients: Children's healthy bone development and general growth are supported by the iron, calcium and vitamins that are abundant in millets (Chauhan, Sonawane and Arya, 2018).

High in fiber: Millets' high dietary fiber content, helps children's gut bacteria to grow and maintain digestive health by reducing constipation (Shobana, 2013).

Balanced carbohydrates: Because millet contains complex carbs, it releases energy gradually, assisting with blood sugar regulation and giving active children long-lasting fuel. (Chauhan *et al.*, 2018).

Gluten-free alternative: Because millets are gluten-free, they can be consumed by children who have celiac disease or gluten sensitivity, promoting a varied and inclusive diet. (Bhat *et al.*, 2018; Sachdev *et al.*, 2023).

Protein source: For growing children, millets are an excellent source of plant-based proteins that are essential for the growth of muscles and general body upkeep. (Tripathi, Patel, Borah and Das, 2023).

Nutritional benefits of millets in children

A review of published studies was conducted and the results were published in the journal *Nutrients* led by Dr. S. Anitha, Senior Scientist-Nutrition at the International Crops Research Institute of the Semi-Arid Tropics (ICRISAT), it involved seven organizations across four nations (Bhat *et al.*, 2018). In her study, Dr. Anitha highlighted the high dense nutrient content of finger millets, especially the available concentration of proteins, amino acids and calcium. The review included infants, preschoolers, school-age children and teenagers. Finger millet was utilized in

Table 1: Nutritional benefits of millets (Singh and Singh, 2016). (For 100 g of each cereal).

Millets	Protein (g)	Fibre (g)	Mineral (g)	Iron (mg)	Calcium (mg)
Pearl millet	10.6	1.3	2.3	16.9	38
Finger millet	7.3	3.6	2.7	3.9	344
Foxtail millet	12.3	8.0	3.3	2.8	31
Proso millet	12.5	2.2	1.9	0.8	14

five of the review's studies, sorghum was used in one and a combination (Anitha, 2022) of millets-finger, pearl, foxtail, tiny and Kodo millets-was used in two. When compared to children on standard rice-based diets, there was a relative rise of 28.2% in mean height, 26% in weight, 39% in the mid-upper arm circumference and 37% in the chest circumference among the children fed millet-based meals. The children in the study consumed millet for a period of 3.5 months to 4 years (Anitha, 2022).

The dual problem of malnutrition and tuberculosis in certain states of India can be addressed by incorporating millet-based meals. Undernourished children are immunodeficient to active TB infections compared to those having healthy body weight (Jyoti Prasad Nautiyal, 2023).

Dr. Jacqueline Hughes, Director General of ICRISAT and Dr. Hemalatha, Director at India's National Institute of Nutrition (NIN), emphasized the need for nutrition intervention programs with the aim of incorporating millets in meals, especially in school feeding programs (Anitha, 2022).

According to the studies, Dr. Givens mentions that millets can help with a wide range of dietary and health requirements. In addition to combating undernutrition in children, they also help control type 2 diabetes, overcome iron deficiency anemia, reduce total cholesterol, reduce obesity and lessen the risk of cardiovascular disease (Bisoi *et al.*, 2012).

Furthe rmore, finger millet has a high natural calcium content (364±58 mg/100 g of grain), of which the body typically retains about 23%. According to published data, finger millet contains about 28% bioavailable calcium, or about 100 mg of bioavailable calcium per 100 grams of grain. If sufficiently ingested, this could aid people who are deficient in calcium, according to Anitha (2022).

All the research was conducted in India using typical rice-based diets. Additionally, the researchers looked at diets that were substantially more varied and included more fruits, vegetables, dairy products and staples. This suggests that minor dietary modifications involving the addition of a greater variety and nutrient-dense foods, such as substituting rice with millets, can have a positive impact on children's development.

Rich in nutrients

Millets, especially finger millet, are rich in minerals (iron, calcium and phosphorus), proteins, dietary fiber and vitamins (especially B-complex vitamins). The general growth and development of children depend on these nutrients (Shobana, 2013).

High calcium content

Particularly finger millet has been demonstrated to contain three times the calcium of milk. Adequate calcium intake is necessary for bone growth, especially during childhood and adolescence. (Chandrasekara and Shahidi, 2011).

Rich in protein

Millets, notably finger millet, are good providers of plant-based proteins. For children's overall growth and the development of their muscles, proteins are essential (Shobana, 2007).

Antioxidant source: Finger millets are enriched with phenolics which are natural antioxidants, they support general health by reducing oxidative stress (Shahidi and Chandrasekara, 2011).

Table 2: Amino acid profiles of different millet grains variety (Foxtail, Proso, Pearl and Finger millet). (Amadou *et al.*, 2013).

Amino acids(g/100 g)	Foxtail millet	Proso millet	Pearl millet	Finger Millet
Essential Amino Acids				
Isoleucine	4.59	4.1	5.1	4.3
Leucine	13.60	12.2	14.1	10.8
Lysine	1.59	1.5	0.5	2.2
Methionine	3.06	2.2	1.0	2.9
Phenylalanine	6.27	5.5	7.6	6.0
Threonine	3.68	3.0	3.3	4.3
Valine	5.81	5.4	4.2	6.3
Histidine	2.11	2.1	1.7	2.3
Tryptophan	NA	0.8	1.2	NA
Nonessential Amino Acids				
Alanine	9.30	10.9	8.1	6.1
Arginine	3.00	3.2	0.9	3.4
Aspartic acid	7.71	6.2	6.2	5.7
Cystine	0.45	NA	0.8	NA
Glutamic Acid	22.00	21.3	22.8	23.2
Glycine	2.91	2.1	0.7	3.3
Serine	4.56	6.3	5.4	5.3
Tyrosine	2.44	4.0	2.7	3.6
Proline	5.54	7.3	8.2	9

Advantageous for particular dietary requirements

Because of their nutrient profile, pearl millets (Rupesh *et al.,* 2018) can be a useful tool for filling in nutrient gaps that are frequently present in diets that follow conventional guidelines for kids with special needs (Hithamani and Shrinivasan, 2014).

Action plan for popularizing millets

Millets can be introduced in children' diet gradually, they can be added into popular foods like pulao, dosa, or roti (Verma and Patel, 2013). Delicious millet-based goodies like muffins or cookies can be prepared by using popular millet flours. One can offer a variety of millet forms, including flakes, flour and whole grains millet bars to ensure options (Dharshini and M, 2023). It is important to be compassionate and patient as these nutrient-dense replacements are gradually incorporated into regular meals.

A thorough approach is needed to child-rearing adults about the nutritional benefits of millets. Nutritionists might be directly engaged through educational workshops and seminars that offer comprehensive insights and cooking demonstrations. Accessible pamphlets and interactive materials can be provided via community outreach initiatives, which include information booths at markets, health fairs and local events. Social media and online platforms allow to produce interesting content like recipes and blog entries about the health benefits of millets. Incorporating millet-based nutrition education into routine check-ups can be ensured by collaboration with healthcare providers.

School programs, parenting seminars and support groups can offer individualized settings for information exchange. Cooking lessons and demonstrations, in addition to collaborations with parenting and women's organizations could help increase awareness. Bite-sized information may be easily distributed through mobile apps and text messaging services. Information can be made more accessible by printing documents in the native tongues, which guarantees cultural relevance. With the help of this comprehensive strategy, caregivers can incorporate the nutritional advantages of millets into their daily lives and feel more empowered to make informed food decisions for their family.

CONCLUSION

An extensive review of research emphasizes the numerous benefits of introducing millets, particularly finger millet, into children's diets. Millets are rich in proteins, dietary fiber, vitamins and minerals while being easily available and cost effective. This makes them a comprehensive nutritional resource for growing children (Hassan *et al.*, 2021). This review underscores the significance of millets in tailoring diets to the specific nutritional needs of kids while also emphasizing their ability to repair nutrient gaps in traditional dietary regimens. This compilation of research supports the idea that including millets in children's meals is a complete and nutrient-dense approach to support healthy development and overall wellbeing.

Conflict of interest

The author certifies that she has no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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