

# Nutrient Rich Millet Based Foods for Children - A Comprehensive Review

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# Abstract

**Background:** Millets, members of the Poaceae family, are hailed for their capacity to deliver high energy and vital nutrients, making them a potent ally in the battle against childhood malnutrition. Their innate characteristics, such as hypolipidemic properties, low glycemic index, and antioxidative prowess, offer formidable defense against various health afflictions. Embedded within the traditional dietary fabric of numerous cultures worldwide, millets stand as dietary staples for more than a third of the global populace. With nutritional values eclipsing those of rice and wheat by three to five times, millets emerge as a transformative force in fortifying global nutrition and health resilience.

The aim of this review is to curate innovative and nutritious recipes featuring millets tailored specifically for children's dietary needs.

**Methods:** The data about nutritional and nutraceutical properties of millets and their recipes are collected from reputed journals such as Pubmed and Google scholar.

**Results:** The study reveals the nutritional and nutraceutical properties of millets and various smart and delicious recipes for children.

**Conclusion:** Despite their abundance in dietary fibers, antioxidants, minerals, phytochemicals, polyphenols, and proteins—attributes known to combat various health ailments—India grapples with persistent malnutrition issues, especially among school-age children. This endeavor seeks to offer innovative millet-based recipes tailored to address malnutrition, promoting healthier growth and development among children.

Keywords: Millets; Nutrition; Smart Recipes

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# Introduction

Millets play a crucial role in traditional diets across many regions worldwide. Known for their resilience in drought-prone areas and their superior nutritional profile compared to staples like rice and wheat, millets are a staple food for over a third of the global population. Varieties such as finger millet (ragi), pearl millet (kambu), foxtail millet (thinai), barnyard millet (kuthiraivaali), kodo millet (varagu), and little millet (samai) are cultivated globally. Millets stand out for their high dietary fiber, antioxidants, minerals, phytochemicals, polyphenols, and proteins, which combat various health disorders. With the rise in sedentary lifestyles contributing to health issues like obesity, diabetes, cardiovascular problems, gastrointestinal disorders, and cancers, integrating millets into our daily diets emerges as a potent solution for better health. Introducing children to a nutrition-rich millet-based diet opens doors to a world of health benefits. Millets, packed with essential nutrients like dietary fibers, antioxidants, minerals, phytochemicals, polyphenols, and proteins, offer a comprehensive approach to nourishing growing bodies [2]. By embracing millet-based recipes, we can provide children with a diverse range of micronutrients crucial for their development and vitality. This dietary shift not only addresses malnutrition but also establishes lifelong habits of nutritious eating, ensuring a healthier future for our children [19].

#### Nutritive Value of Millets

Millets are essential in maintaining nutritional security for people all over the globe by offering calories and protein. They are nutrient powerhouses, boasting 60-70% dietary carbohydrate, 6-19% protein, 1.5-5% fat, 12-20% dietary fiber, 2-4% minerals, and a range of phytochemicals. Rich in Vitamin B, magnesium, and antioxidants, millets offer a plethora of micronutrients and macronutrients. Compared to wheat and rice, millets surpass in both mineral and essential amino acid content. According to USDA data, a one-cup serving (approximately 174 grams) of cooked millet provides the following nutritional values:

#### Table1: Nutritive value of one-cup serving of cooked millet [20]

Calories	207
Fat	1.7g
Sodium	3.5g
Carbohydrate	41.2g
Fiber	2.3g
Sugar	0.2g
Protein	6.1g
Magnesium	76.6mg
Folate	33.1mcg

#### Significance of Millets

Various types of millet whole grains, including kodo, finger, foxtail, proso, pearl, and little millets, are rich sources of phenolic compounds with antioxidant, metal-chelating, and reducing properties. *Fermented millet products serve as natural probiotic therapies for childhood diarrhea, while whole grain millets act as prebiotics, promoting the growth of beneficial gut bacteria crucial for digestion.* Consumption of whole-grain meals is linked to a reduced risk of diabetes mellitus, with millet-consuming communities showing lower incidences of the disease [18]. Being glutenfree, millets are an excellent choice for individuals with celiac disease and gluten sensitivities. Despite containing phytates, phenols, and tannins, which contribute to antioxidant activity, millets remain high in antioxidants and phenolics, essential for overall health, aging and metabolic syndrome [8]. As a staple ingredient, millet holds a long-standing tradition of contributing to the production of a wide array of nutritious food items [1].

#### **Cholam (Sorghum Bicolor)**

Sorghum protein consists mainly of prolamin, known as kaffirin, which uniquely decreases digestibility upon cooking, offering potential health benefits for specific dietary needs. Sorghum is a nutritional powerhouse, abundant in protein, fiber, thiamine, riboflavin, folic acid, and beta-carotene. It is also packed with essential minerals such as potassium, phosphorus, and calcium, along with adequate levels of iron, zinc, and sodium [15].

#### **Recipes from Cholam**

**Cholam Dosa:** Combine soaked sorghum grain and black gram dal, then grind them into a smooth batter. Add salt for flavor and let the batter ferment. Heat a dosa making tawa, grease it with oil, and pour a ladleful of batter onto it. Spread the batter thinly and cook until golden brown and crisp. Serve the dosas hot with chutney for a delicious meal.

**Cholam Idli:** Soak sorghum grain and black gram dal, then grind them into a smooth batter. Add salt to taste and let the batter ferment. Grease stainless steel idli molds and pour the batter into them. Steam for 15-20 minutes until the idlis are cooked through. Serve hot with chutney for a wholesome and nutritious meal.

**Cholam Roti:** Sift sorghum flour and gradually add hot water to it, kneading until you achieve a smooth, soft dough. Divide the dough into smaller portions and shape them into round balls. Flatten each ball into a round shape on a polythene sheet using either a rolling pin or your hands. Cook the roti on a preheated tawa until golden brown on both sides. Serve hot with your preferred curry or dal for a satisfying meal.

**Cholam Halwa:** Roast sorghum flour with ghee in a pan until fragrant and golden brown. Gradually add milk to the mixture and cook until thickened. Stir in melted jaggery and ghee, ensuring there are no lumps, and continue cooking until the mixture reaches a thick consistency. Transfer the mixture to a mold and let it set until firm.

#### Kambu (Pennisetum Glaucum)

Because of its elevated iron content (8mg/100g)

and high zinc levels (3.1mg/100g), pearl millet may boost hemoglobin levels. It surpasses all other cereals in niacin content, making it beneficial for health. Its low glycemic index makes it suitable for managing diabetes mellitus. Additionally, its hypoallergenic properties make it safe for inclusion in the diets of infants, lactating mothers, the elderly, and convalescents. The significant magnesium concentration aids in alleviating respiratory issues, particularly for asthma patients [9].

#### **Recipes from Kambu**

Kambu Roti: Sift pearl millet (kambu) flour and gradually add hot water to it, kneading until you achieve a smooth, soft dough. Divide the dough into smaller portions and shape them into round balls. Flatten each ball into a round shape on a polythene sheet using either a rolling pin or your hands. Cook the roti on a preheated tawa until golden brown on both sides. Serve hot with your preferred curry or dal for a satisfying meal.

**Kambu Halwa:** Roast pearl millet (kambu) flour with ghee in a pan until fragrant and golden brown. Gradually add milk to the mixture and cook until thickened. Stir in melted jaggery and ghee, ensuring there are no lumps, and continue cooking until the mixture reaches a thick consistency. Transfer the mixture to a mold and let it set until firm.

**Kambu Khichidi:** Soak pearl millet (kambu) and moong dal overnight. Pressure cook the soaked millet and dal with vegetables, green chilies, salt, and turmeric powder. In a separate pan, temper mustard seeds, cumin seeds, asafoetida, and sauté onion, ginger garlic paste, and tomato. Add red chili powder, coriander powder, and mix in the cooked millet and dal mixture. Let it simmer for a few minutes before garnishing with coriander leaves and lemon juice. Serve hot.

#### Kezhvaragu (Eleusine Coracana)

With calcium levels ranging from 300-350 mg/100g, finger millet boasts a rich source of protein with a well-balanced composition of essential amino acids, along with Vitamin A, Vitamin B, and phosphorus. Its high fiber content aids in preventing constipation, reducing high

blood cholesterol, and lowering the risk of intestinal cancer [16]. The protein content in finger millet is particularly significant, making it an essential component in combating malnutrition. For diabetics, finger millet serves as an ideal food as it effectively regulates blood glucose levels and hyperglycemia. Its sulfur-rich amino acid content sets it apart, while Vitamin E promotes natural wound healing and acts as a natural anti-aging ingredient, making it beneficial for skincare [10].

#### **Recipes from Ragi**

**Ragi Onion Chapati:** Mix finger millet (ragi) flour with chopped onion, salt, green chili, curd, water, and coriander leaves to form a soft dough. Heat a pan greased with oil. Shape the dough into small rotis by pressing with oiled palms and cook them on low flame until golden brown on both sides. Serve the rotis with curd, pickle, or your favorite curry for a delicious meal.

**Ragi Laddu:** Roast finger millet (ragi) flour until aromatic. In a separate pan, toast assorted dry fruits in ghee until golden. Heat milk and dissolve sugar in it to make a syrup. Combine the roasted flour, dry fruits, syrup, and cardamom powder, mixing thoroughly. Add coconut gratings for extra flavor. Shape the mixture into round lemon-sized balls manually. Serve and enjoy these delightful treats.

**Ragi Halwa:** Roast finger millet (ragi) flour with ghee in a pan until fragrant and golden brown. Gradually add milk to the mixture and cook until thickened. Stir in melted jaggery and ghee, ensuring there are no lumps, and continue cooking until the mixture reaches a thick consistency. Transfer the mixture to a mold and let it set until firm.

**Ragi Dosa:** Combine soaked finger millet (ragi) and black gram dal, then grind them into a smooth batter. Add salt for flavor and let the batter ferment. Grease a dosa making tawa with oil and pour a ladleful of batter onto it. Spread the batter thinly and cook until golden brown and crisp. Serve the dosas hot with chutney for a delicious meal.

#### Thinai (Setaria Italica)

Foxtail millet stands as a nourishing choice for children and expectant mothers alike. Abundant in dietary

fiber and essential minerals like copper and iron, it fortifies the body's immunity and strength. Notably, foxtail millet surpasses rice in calcium, magnesium, copper, iron, and phosphorus content. Additionally, it boasts a wealth of vitamins, including vitamin A, B1, B2, and E, contributing to overall health and vitality [4].

#### **Recipes from Thinai**

Thinai Kheer: Cook dehulled foxtail millet (thinai) in boiling water for 5 minutes. Meanwhile, roast dry fruits in ghee until golden brown. In a separate pot, boil water and milk together, then add the cooked foxtail millet (thinai). Sweeten with sugar and stir slowly until thickened. Flavor with cardamom powder and garnish with roasted dry fruits. Serve hot as a delightful traditional dessert.

Thinai Thengai Sadham: Soak foxtail millet (thinai) for 2 hours and cook until fully done. In a pan, heat ghee and add mustard seeds, chopped onions, green chilies, and curry leaves, sautéing until onions are translucent. Add the cooked foxtail millet (thinai) and grated coconut, and cook for two minutes. Season with salt as per taste and serve hot, garnished with chopped coriander leaves.

Thinai Vegetable Briyani: Boil foxtail millet (thinai) until three-fourth done and set aside. Boil the chopped vegetables separately and keep them aside. In a pan, roast whole spices including cardamoms, cloves, cinnamon, and bay leaf with caraway seeds. Add tomatoes, ginger-garlic paste, onions, and boiled vegetables. Season with spices and simmer. Layer cooked millet with vegetables, sprinkle with fried onions, lemon juice, and fresh herbs. Cover and let it cook for a few minutes. Serve hot.

#### Varagu (Paspalum Scrobiculatum)

Kodo millet boasts 8% protein content, making it a valuable protein source. It's also packed with fiber, providing essential digestive support. With 66.6 grams of carbohydrates, it offers sustained energy [4]. This millet is a treasure trove of B vitamins, particularly niacin, pyridoxine, and folic acid, along with vital minerals like calcium, iron, potassium, magnesium, and zinc. Additionally, its high lecithin content enhances the nervous system, promoting overall well-being [5].

#### **Recipes from Varagu**

**Varagu Upma:** Rinse kodo millet (varagu) thoroughly and set aside. Prepare a mixture of chopped onions, green chilies, carrots, beans, and potatoes along with grated ginger. In a pressure cooker, heat oil and add mustard seeds, black gram dal, bengal gram dal, and curry leaves. Once the dal turns golden brown, add the onion mixture and sauté until golden brown. Stir in turmeric powder and add the vegetables, sautéing for a few minutes. Then add the kodo millet (varagu) and water, and pressure cook for 3 whistles. Once done, serve hot with preferred accompaniment.

Varagu Pulao: In a small pressure cooker, heat ghee and add cinnamon, fennel seeds, and bay leaf. Sauté until fragrant. Add chopped onion and ginger garlic paste, cooking until onions are golden brown. Stir in chopped vegetables, green chilies, mint leaves, and salt. Add washed and drained kodo millet (varagu) and mix well. Pour water, adjust salt, and bring to a boil. Cook for one whistle on medium or low flame. Serve hot, garnished with coriander leaves.

**Varagu Malli Rice:** Cook kodo millet (varagu) in a pressure cooker with water, salt, and bay leaf until done. Meanwhile, prepare coriander chutney with minimal water. In a pan, heat oil and fry whole spices. Add chopped onion and cook until translucent. Stir in chopped carrots and mint chutney, cooking until the raw taste of coriander disappears. Season with salt. Once the cooked millet has cooled, mix it evenly with the vegetable mixture. Serve hot with raita.

**Varagu Payasam:** Combine kodo millet (varagu), saffron, and milk in a pot and cook on low heat until the millet is soft and mashed. Stir in sugar to sweeten the payasam. In another pan, melt ghee and roast the mixed dry fruits until golden. Add the roasted dry fruits to the cooked payasam. Serve the payasam either hot or chilled.

**Varagu Adai:** Soak kodo millet (varagu), toor dal, chana dal, moong dal, and urad dal for 4 hours. Drain and set aside. Grind red chilies and fennel seeds with a portion of soaked mixture to a coarse paste. Mix with chopped onion, coriander leaves, and salt. Adjust the batter consistency. Cook adais until golden brown. In another pan, sauté onion and ginger garlic paste, then add chopped veggies and mint leaves. Serve hot adais garnished with coriander leaves and accompany with chutney.

#### Kuthiraivaali (Echinochloa Frumentacea)

It serves as a potent source of crude fiber and iron, vital for sustaining the body's immune defenses. The micronutrients within play a pivotal role in supporting cellular functions, especially crucial for pregnant and lactating mothers, young children, and the elderly [17]. Additionally, its grains harbor functional compounds like Gamma aminobutyric acid (GABA) and Beta-glucan, known for their ability to lower blood lipid levels [6].

#### **Recipes from Kuthiraivaali**

**Kuthiraivaali Pudhina Rice:** Cook barnyard millet (kuthiraivaali) with water, salt, and bay leaf in a pressure cooker until done. Meanwhile, prepare pudhina chutney. In a pan, heat oil and fry whole spices. Add chopped onion and cook until translucent. Add chopped carrots and pudhina chutney, cooking until the raw taste disappears. Season with salt. Once the millet has cooled, mix it with the vegetable mixture. Serve hot with raitha.

**Kuthiraivaali Payasam:** Combine barnyard millet (kuthiraivaali), saffron, and milk in a pot and cook on low heat until the millet is soft and mashed. Stir in sugar to sweeten the payasam. In another pan, melt ghee and roast the mixed dry fruits until golden. Add the roasted dry fruits to the cooked payasam. Serve the payasam either hot or chilled.

#### Samai (Panicum Sumatrense)

Little millets are renowned for their high fiber content, closely following barnyard millets. The flavonoids found in little millets are crucial for bolstering the body's defense mechanisms and immune system. Additionally, little millets boast abundant tannins and flavonoids, which offer protection against a variety of diseases, including diabetes, cardiovascular diseases, cataracts, cancer, inflammation, gastrointestinal problems, and even aid in delaying the aging process [7].

#### **Recipes from Samai**

**Samai Payasam:** Boil dehulled little millet (samai) in water for 5 minutes until cooked. In a separate pan, lightly roast dry fruits in ghee. Heat milk in another pan and add the cooked millet. Sweeten with sugar and cook until the mixture thickens. Flavor with cardamom powder and garnish with roasted dry fruits. Serve hot as a traditional sweet.

Samai Thayir Sadham: Cook little millet until soft. Mash it and mix with yogurt and milk. In a separate pan, heat oil and temper with mustard seeds, split urad dal, curry leaves, green chili, and ginger. Pour over the millet mixture and add grated carrot, chopped coriander leaves, and salt. Mix well and serve chilled, garnished with additional carrot and coriander leaves.

Samai Mushroom Biryani: Rinse the Samai thoroughly and soak it in water for about 30 minutes. Heat ghee or oil in a deep pan. Add the whole spices and sauté until aromatic. Add the chopped onions and sauté until they turn translucent. Stir in the ginger garlic paste and cook for a minute until fragrant. Add the chopped tomatoes and cook until they become soft and mushy. Now, add the sliced mushrooms and cook until they are slightly tender. Add turmeric powder, red chili powder, garam masala, and salt. Mix well to coat the mushrooms evenly. Drain the soaked Samai and add it to the pan. Stir gently to combine with the mushroom mixture. Pour in the water and yogurt. Stir well and bring it to a boil. Once boiling, reduce the heat to low, cover the pan, and let it simmer for about 15-20 minutes or until the Samai is cooked and all the water is absorbed. Once done, fluff the biryani gently with a fork. Garnish with chopped coriander leaves, mint leaves, and fried onions if desired. Serve hot with raita or any side dish of your choice. Enjoy delicious and wholesome Samai Mushroom Biryani.

Samai Thakkali Sadham: Rinse the Samai under running water until the water runs clear. Soak the Samai in water for about 30 minutes, then drain and set aside. Heat oil in a pressure cooker over medium heat. Add mustard seeds and cumin seeds. Let them splutter. Add chopped onions and sauté until they turn golden brown. Add grated ginger and minced garlic. Sauté for another minute until the raw smell disappears. Add chopped tomatoes and green chili. Cook until the tomatoes turn soft and mushy. Stir in turmeric powder, red chili powder, coriander powder, and garam masala. Mix well and cook for 2-3 minutes. Add the soaked and drained Samai to the cooker. Mix well with the tomato mixture. Pour in 2 cups of water and season with salt to taste. Stir well to combine. Close the pressure cooker lid and cook for 2 whistles on medium heat. Once the pressure releases naturally, open the lid and gently fluff up the Samai Thakkali Sadham with a fork. Garnish with freshly chopped coriander leaves. Serve hot with raita or pickle. Enjoy delicious and nutritious Samai Thakkali Sadham.

# **Result and Discussion**

Studies conducted by ICRISAT have unveiled compelling evidence that integrating millets into regular meals can markedly boost the growth of children and adolescents by as much as 39% compared to diets reliant solely on rice.[3] A comprehensive review encompassing infants, preschoolers, and school-aged children revealed significant enhancements in height, weight, mid-upper arm circumference, and chest circumference among those consuming millet-based meals. Furthermore, supplementation with sorghum recipes showcased a decrease in the prevalence of protein-energy malnutrition and an improvement in overall nutritional status.[12] Another study spotlighted the efficacy of ragi biscuits, demonstrating advancements in height, weight, hemoglobin levels, and cognitive function among children aged 2-3 years over a 3-month period.[14] These findings underscore the pivotal role of millets in addressing a spectrum of nutritional and health challenges, including child under nutrition, management of type 2 diabetes, alleviation of iron deficiency anemia, reduction of total cholesterol levels, management of obesity, and mitigation of cardiovascular disease risk.

# Conclusion

Millets emerge as a nutritional treasure trove, offering a plethora of essential nutrients catering to diverse health needs worldwide. Extensive scientific research underscores their efficacy not only in tackling child under nutrition but also in managing conditions like type 2 diabetes, reducing overall cholesterol levels, combating obesity, and alleviating iron deficiency anemia. An abundance of studies substantiates that integrating millets into diets markedly enhances nutrient intake and curbs deficiencies. With the incorporation of millet-centric recipes, such as the 25 options provided in the article, into daily culinary routines, individuals can champion improved growth and development in children while effectively addressing malnutrition and other prevailing health concerns.

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# Consent

It is not applicable.

# **Ethical Approval**

It is not applicable.

# **Competing Interests**

Author has declared that no competing interests exist.

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