Article: RT728


Biotica Research Today

Vol 3:9 793/796

2021

# Small Millets (Nutri cereals): Food for the Future

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**Keywords**

COVID-19, Food security, Nutri-cereals, Small Millets

**Article History**

Received in 13th September 2021

Received in revised form 21st September 2021

Accepted in final form 22nd September 2021

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***How to cite this article?***

Sanyal *et al.*, 2021. Small Millets (Nutri cereals): Food for the Future. Biotica Research Today 3(9): 793-796.

## Abstract

Small millets are traditional staple food in dry land areas and are well known as Nutri-cereals due to high nutrient content. The most important cultivated species of small millets are Foxtail millet (Kangni), Finger millet (Mandua), Little millet (Kutki), Kodo millet, Barnyard millet (Jhangora), and Proso millet (Cheena). Minor millets are loaded with full of macro- and micro-nutrients like Ca, Mg, Mn, Zn, Fe, phosphorous, fibre, B complex vitamins. Millets have nutraceutical properties in the form of antioxidants which are essential to human body. These minor millets perform well in marginal land, require very less water for their cultivation and can withstand severe climatic conditions. Small millets are more environment friendly with high water use efficiency and low input requirement, which make them farmer friendly. Therefore, there is need to develop new high yielding varieties to increase the area under minor millets crops to achieve nutritional security in the country.

## Introduction

Among the 7.8 billion global populations, 820 million people experience chronic hunger, of which, 135 million people are surviving in acute food insecurity zones across 55 countries (FSIN, 2020). Disruptions in global supply chains, economic consequences, loss of jobs and incomes, ban on the export of agricultural commodities, and price hike during the pandemic have aggravated the situation. Although much attention is being given to the development of vaccines as a preventive measure to combat COVID-19, the invisible threat to the lives and livelihoods of marginal populations through hunger and malnutrition remains largely unaddressed. Countries such as India, Sudan, Ethiopia, Somalia, Yemen, Bhutan, and Sri Lanka, where more than 31% of children under 5 years of age are stunted and 15% are too thin for their height, will be worst affected owing to the combined effects of disease and hunger. Devising long-term plans to prevent such challenges is the need of the hour and mainstream production of underutilized crops can be a very good strategy.

'Small millets' is a generic term that denotes the coarse cereals, which includes finger millet (*Eleusine coracana*), foxtail millet (*Setaria italica*), Kodo millet (*Paspalum scrobiculatum*), proso millet (*Panicum miliaceum*), barnyard millet (*Echinochloa crus-galli*), little millet (*Panicum sumatrense*), teff (*Eragrostis tef*), fonio (*Digitaria exilis*), guinea millet (*Brachiaria deflexa*), Job's tears (*Coix lacryma-jobi*), and browntop millet (*Urochloa ramosa*). Introduction of cash crops restricted their cultivation to some arid regions where other crops are difficult to grow. Compared to major cereals (Rice, Wheat and Maize), small millets have better water use efficiency, nutrient use efficiency, lower global warming potential (GWP), better resistance to biotic and abiotic stresses and are nutritionally dense.

Small millets have short growing season, ready to harvest in between 70-80 days and they can be very well fitted into multiple cropping systems both under irrigated as well as dry farming conditions. Each of the millets is three to five times nutritionally superior to the widely promoted rice and wheat in terms of proteins, minerals and vitamins. Small millets are rich in micro- and macro-nutrients, total protein, fiber, and resistant starch. For example, finger millet is rich in calcium (344 mg per 100 g), little millets have high iron contents (9.3 mg per 100 g). Barnyard millet, foxtail millet, kodo millet and finger millet are rich in minerals. Psoro millet and kodo millet are rich in magnesium (> 145 mg per 100 g). The total protein is high in foxtail millet and proso millet (> 12%), and crude fiber is higher than major cereals in all small millets. Small millets also have relatively higher amount of essential fatty acids and vitamin $B_2$ content. Moreover, the majority of small millets are gluten-free and therefore are of low glycemic index which can be beneficial for diabetic patients.

Intervention of small millets can reduce the dependency on rice and wheat as the staple food for majority of the global population. Having comparable amount of carbohydrates, proteins and fats make them equally energy dense with no compromise in taste and texture that are considered to be essential traits for consumer preference. Rice, wheat, and maize make up 60% of all staple crops, resulting in a monotonous diet and any disruption in production due to natural calamities or pandemics like this can put the humankind at risk. In addition to small millets, underutilized tubers (cassava, sweet potato, taro, elephant foot yam, *etc.*) and legumes (rice bean, winged bean, lima bean, velvet bean, *etc.*) could add to food and dietary diversification.

Table 1: Comparative table showing the nutritional values of different small millets and major cereals

| Food Grain | Finger millet (Mandua) | Kodo millet (Kodon) | Proso millet (Barre, Cheena) | Foxtail/ Italian millet (Kangni, Kakum) | Little millet (Kutki) | Barnyard millet (Sanwa, Jhangora) | Rice (Chaval) | Wheat (Gehun) |
|---|---|---|---|---|---|---|---|---|
| Scientific Name | *Eleusine coracana* | *Paspalum scrobiculatum* | *Panicum miliaceum* | *Setaria italica* | *Panicum sumatrense* | *Echinochloa crus-galli* | *Oryza sativa* | *Triticum aestivum* |
| Carbohydrates (g) | 72 | 65.9 | 70.4 | 60.9 | 67 | 65.5 | 71.2 | 78.2 |
| Protein (g) | 7.3 | 8.3 | 12.5 | 12.3 | 7.7 | 6.2 | 11.8 | 6.8 |
| Fat (g) | 1.3 | 1.4 | 1.1 | 4.3 | 4.7 | 2.2 | 1.5 | 0.5 |
| Energy (kcal) | 328 | 309 | 341 | 331 | 341 | 307 | 346 | 345 |
| Crude fibre (g) | 3.6 | 9 | 2.2 | 8 | 7.6 | 9.8 | 1.2 | 0.2 |
| Minerals (g) | 2.7 | 2.6 | 1.9 | 3.3 | 1.5 | 4.4 | 1.5 | 0.6 |
| Ca (mg) | 344 | 27 | 14 | 31 | 17 | 20 | 41 | 10 |
| P (mg) | 283 | 188 | 206 | 290 | 220 | 280 | 306 | 160 |
| Fe (mg) | 3.9 | 0.5 | 0.8 | 2.8 | 9.3 | 5 | 5.3 | 0.7 |
| Mg (mg) | 137 | 147 | 153 | 81 | 133 | 82 | 90 | 138 |
| Total Essential Amino Acids (mg/g of N) | 308 | 293 | 284 | 329 | 272 | 282 | 276 | 212 |
| Riboflavin (mg) | 0.19 | 0.09 | 0.28 | 0.11 | 0.09 | 0.1 | 0.04 | 0.1 |

*All amounts in unit per 100 g. (Source: Gopalan *et al*., 2007; Longvah *et al*., 2017)

## Nutritional Importance of Small Millets

Due to high levels of insoluble dietary fibre, phytates, phytochemicals, catechins, flavonoids and minerals (like copper and iron), small millets are very healthy. The high amount of resistant starch promotes slow catabolism of complex carbohydrates by the gut microbiota, leading to slow and sustained release of glucose into the bloodstream. This is beneficial for diabetic patients and individuals with gastric problems. When consumed on regular basis, they lower bad cholesterol and increase good cholesterol, making them heart-healthy diets. The essential amino acid pattern (particularly, lysine) in these millets suggest possible use as a

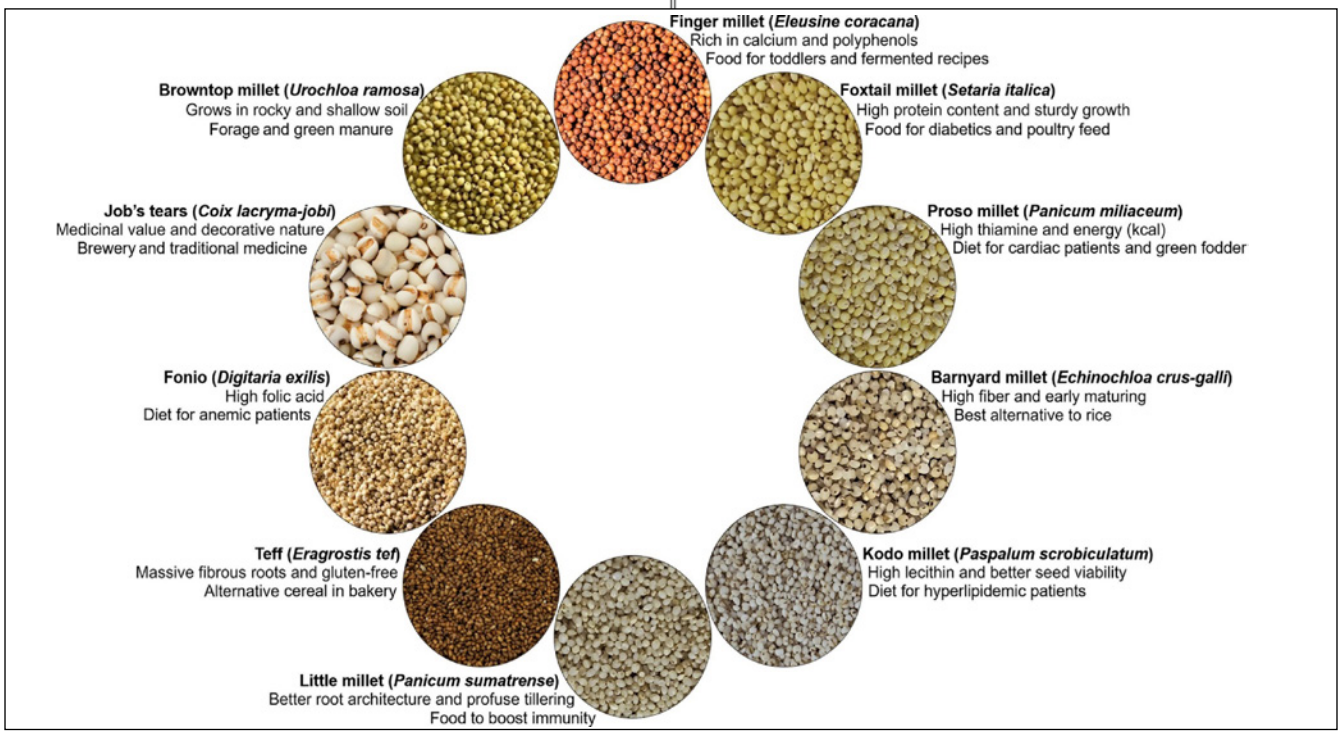


Figure 1: Types of small millets and their grain morphologies [Source: Muthamilarasan *et al*., 2021]

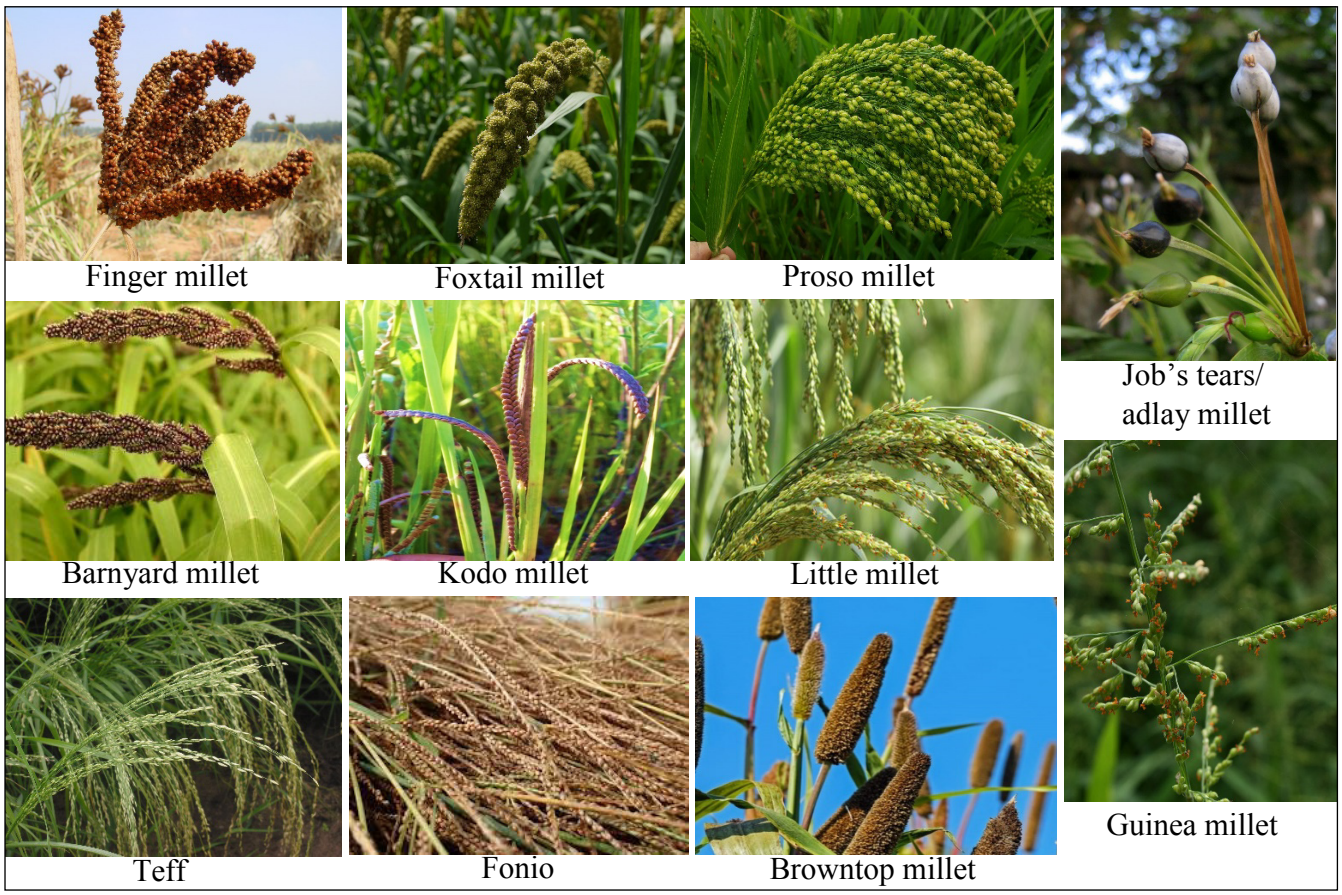


Figure 2: Panicles of small millets in field condition

supplementary protein source to most cereals. Yellow seeded cultivars of foxtail are medicinally used as astringent, digestive, emollient and stomachic. It is also used in the treatment of dyspepsia and poor digestion. White seeded cultivars of foxtail act as refrigerant and can be used in the treatment of cholera and fever while the green seeds are diuretic and strengthening to virility. Millet oil is rich in linoleic acid and tocopherols having antioxidative properties. The best alternative crop for diversifying and intensifying winter wheat-based dryland production systems is Proso millet. Besides being a rich source of B vitamins (vitamin $B_6$ and folic acid), proso millet has improved glycaemic responses, which makes it a potential candidate for therapeutic intervention in type-2 diabetes (Rao *et al*., 2017).

## Strategies to Bring Small Millet Cultivation to the Forefront

• Suitable millet species and variety should be identified for cultivation and farmer training programmes should be organized to promote this concept.

• Germplasm repositories throughout the world must be utilized to facilitate the release of good quality seed materials.

• Majority of germplasms in the gene-banks belong to foxtail millet, finger millet and proso millet and shifting to cash crop cultivation resulted in loss of several germplasms. Germplasm conservation drive is necessary to restore them.

• Lodging and seed-shattering is a major problem in millet cultivation which needs development of resistant cultivars.

• Higher lipid content of small millets causes rancidity of grain and lack of proper processing and storage facilities adds to the problem. Development of storage facility is required to tackle malnutrition indices during natural calamities or future pandemics.

• Millet grain contains significant levels of antinutrients, including phytic acid that inhibits the bioavailability of nutrients (*e.g.*, uptake of iron) to the human system. Elite lines with low phytic acid content could be developed using genomics-assisted breeding or transgene-based approaches.

• Genome and transcriptome sequence information for a few small millets (foxtail millet, finger millet, barnyard millet, and teff) are already available which must be used for genetic improvement programs.

## Conclusion

Small millets or 'nutri-cereals' have the potential to support the huge dependency on major cereal crops like rice, wheat and maize. They have similar nutritional profile with better adaptability, making them climate resilient crops. Prioritizing millet cultivation in 'hunger hotspot' regions is possible with the development of cultivars with improved beneficial traits, deploying better agronomic practices, and optimizing storage and supply chains. The year 2023 has already been announced as 'International Year of Millets' by the UN-Food and Agriculture Organization (FAO), recognizing the potential of this crop. By that time, it is the responsibility of the government and non-governmental organizations to incentivize millet production and revive millet farming which can play crucial role in combating hunger and malnutrition among the vulnerable population in any future adverse conditions.

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