ISSN No: 0976-5921
Published online at https://ijam.co.in
International Journal of Ayurvedic Medicine, Supplement of International Conference on Ayurveda-Yoga-Nathpanth - 2025

Finger Millet: A Comprehensive Review

Review Article

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Abstract

This review aims to evaluate the nutritional and health benefits of Finger millet, as well as its production and utilization. Finger millet (*Eleusine coracana L.*), also known as *ragi* or *mandua*, is one of the key millets cultivated widely across various regions of India and Africa. It is a highly nutritious grain, rich in calcium, dietary fibre, iron, protein, antioxidants, and vitamins. Thanks to its nutrient density, it aids in managing diabetes, preventing osteoporosis, improving digestion, and supporting weight loss. Agriculturally, finger millet is a resilient crop, thriving in drought conditions with minimal input, contributing to sustainable farming practices. Its adaptability and low resource needs make it valuable for climate-resilient agriculture. Known for its antioxidative and anti-inflammatory properties, finger millet may also help in preventing cardiovascular diseases and cancer. The production of rice influences the consumption of millet in India. Millets offer exceptional nutraceutical properties and exhibit resilience to adverse climatic conditions, which can contribute to food and nutritional security in the modern era. This review synthesizes current research on the health-promoting properties of finger millet, including its potential to combat lifestyle diseases. Overall, this review highlights the multifaceted importance of finger millet as a nutritionally dense, environmentally sustainable, and health-promoting crop, advocating for its wider inclusion in both rural and urban diets as a response to contemporary food security and health challenges.

Keywords: Nutrient Density, Antioxidant, Food Security, Diabetes, Dietary Fibre.

Introduction

Finger millet (*Eleusine coracana*) is a cereal cultivated for food in Africa and Southern Asia, particularly in India (notably in the states of Uttar Pradesh, Bihar, Tamil Nadu, Karnataka, and Andhra Pradesh) and Nepal (1). In Africa, it is primarily grown in the eastern regions, especially in Uganda, Kenya, and Tanzania, with smaller-scale cultivation in Ethiopia, Rwanda, Malawi, Sudan, Zambia, and Zimbabwe (2). A large portion of the global population relies on cereals such as wheat, rice, and maize as their primary food sources, while millets have been largely overlooked, especially following the Green Revolution (1). Millets are a varied group of small-seeded grasses cultivated for food, animal feed, or forage. These plants and their grains are resilient to drought, pests, and diseases, and are rich in polyphenols, particularly calcium (3).

Brief History of the Crop

Finger millet originated and was domesticated in Africa. Archaeological and linguistic evidences show that around 5,000 years ago, farming communities in eastern Africa were already cultivating this millet (4). The exact area of domestication is unknown, and it has been suggested that it may have occurred anywhere between western Uganda and the Ethiopian highlands of Eastern Africa (2). From Africa, the crop was transported to India about 3,000 years ago, whereupon the subcontinent became its secondary center of diversity. The maritime connections between East Africa and the Arabian Peninsula played a role in its transfer to the Indian subcontinent (5). Finger millet, commonly called *Ragi*, is an exceptional cereal known for its extensive nutritional benefits that can help prevent a variety of diseases. In India, it is also referred to by names such as *mandua* and *nachani*. It is also known to possess immunomodulatory properties(6).

Methodology

A comprehensive literature search was conducted using PubMed, JSTOR, Google Scholar along with specific search terms and keywords included “Finger millet”, “Health Benefit”, “Production Pattern”, and the search was limited to studies published in English between 2010 and 2024. Studies were selected based on relevance to the topic focusing on Finger millet. Articles were excluded if they addressed other cereals and grains.

Taxonomy and Botanical Description

Finger millet (*E. coracana*) and its related species are part of the subfamily *Chloridoideae* within the

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Poaceae family. This crop falls under the genus *Eleusine* and is commonly known as ragi and *mandua* in India, *kaddo* in Nepal, and *fingerhirse* in Germany. It serves as a vital staple food in regions of eastern and central Africa, as well as in India.

Ecological requirements

Millets require warm temperatures for germination and development and are sensitive to frost. For these reasons, they are normally planted from mid-June to mid-July period. Finger millet Best Grows with Medium Rainfall and Annual Temperature Range of 11 to 27 degrees Celsius Low Relative Humidity. It can be grown on a variety of soil ranging from rich loam to poor shallow upland soil with good organic matter (7). Black soil with good drainage can also be considered for cultivation as this crop is sustainable for waterlogging to some extent. Finger millet grows best in soil having pH 4.5-8. Soil having water logging problem should not be used for cultivation of finger millet (8).

Millet Consumption and Nutritional Significance

Reports of the National Nutrition Monitoring Bureau indicated that consumption of millets in general was higher in the states of Gujarat (maize, pearl millet), Maharashtra (sorghum), and Karnataka (finger millet) but almost nil in the states of Kerala, West Bengal, Orissa, and Tamil Nadu where rice forms the major staple (9). The consumption of millets in Gujarat and Maharashtra was 200 g/CU/day and 132 g/CU/day, respectively, which was higher compared to Karnataka (75 g/CU/day), Madhya Pradesh (32 g/CU/day), and Andhra Pradesh (16 g/CU/day). In contrast, Tamil Nadu (3 g/CU/day) and Orissa (1 g/CU/day) showed minimal consumption. millet consumption is relatively low while cereals remain the main staple in Indian diets, contributing 70–80% of total energy intake for the majority of the population (10). Millet consumption is significantly lower compared to rice, as highlighted by a recent study on the dietary profile of urban Indians from the Chennai Urban Rural Epidemiology Study (CURES). The study found that millets contributed to only about 2% of total daily calories (6.7 g/day), whereas nearly half of the daily caloric intake came from refined grains like polished white rice (253.4 g/day) (11).

Nutrient Composition of Finger Millet

Finger millet is a rich source of carbohydrates, containing free sugars (1.04%), starch (65.5%), and non-starchy polysaccharides or dietary fibre (11.5%). Its dietary fibre content (11.5%) is notably higher than that of brown rice, polished rice, and other millets like foxtail, little, kodo, and barnyard millet (12).

Most finger millet varieties have a crude protein content ranging from 5.6% to 12.7%. The protein levels specifically range from 6.7% to 12.3%, with an average of 9.7%. Finger millet is rich in essential amino acids, such as lysine and methionine, which are typically deficient in other plant-based diets. There is variation in protein content across different varieties of finger millet, and prolamins make up the majority of its protein fractions (13).

Finger millet has superior keeping qualities than other minor cereals like pearl millet, barnyard millet, and foxtail millet since it has a lower fat content. Its claimed fat content is between 1.3 and 1.8%. Finger millet has a higher ash content compared to other major cereal grains, with its ash concentration ranging from 1.7% to 4.13% (14). The mineral content of finger millet per 100 grams includes phosphorus (130–283 mg), potassium (430–490 mg), magnesium (78–201 mg), calcium (162–398 mg), sodium (49 mg), zinc (2.3 mg), iron (3.3–14.39 mg), manganese (17.61–48.43 mg), and copper (0.47 mg) (15). When compared to rice and wheat, finger millet has a greater nutritional density. Finger millet is a source of carbohydrates like any other cereal. However, the proportion of dietary fibre in finger millet is higher than in many other kinds of cereal. The dietary and crude fibre of finger millets are 18.6% and 4.3%, respectively (16) . Despite having a minor amount of vitamins A and B, finger millet grains are not a particularly abundant source of vitamins. The grains are lacking in vitamin C but have higher levels of riboflavin, niacin, thiamine, and folic acid (17).

Health Benefits of Finger Millets

The World Health Organization (WHO) has identified 4 major forms of malnutrition crippling globally. This includes vitamin A deficiency, iron deficiency, iodine deficiency and protein energy malnutrition. Millets are a storehouse of nutrients and are a remedy for the malnutrition that affects a vast majority of our population (18). Millet Network of India (Deccan Development Society, FIAN, India) confirmed in their study that, as compared to the other crops (rice and wheat), it is an exceptionally rich source of calcium chromium, zinc, copper and magnesium, essential for good health (17). It is a rich source of non-available carbohydrates with a low glycaemic index, which is beneficial for the prevention of diabetes and cardio-vascular diseases. It also helps in delaying aging by reducing glycosylation of body proteins (19).

Nutrient-rich

Ragi is packed with calcium, iron, dietary fibre, antioxidants, and essential amino acids, making it a highly nutritious grain. It is especially beneficial for individuals with iron deficiency and those needing increased calcium intake.

Gluten-Free and Easily Digestible

Naturally gluten-free, ragi is an excellent choice for people with gluten sensitivities or celiac disease. It is also easily digestible and gentle on the stomach.

Promotes Bone Health

With its high calcium content, ragi supports bone development and helps maintain bone density, making it beneficial for children and older adults in preventing conditions like osteoporosis.

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Manages Diabetes

Ragi's low glycaemic index helps manage blood sugar levels. Its high fibre content slows sugar absorption, making it ideal for those with diabetes or at risk of developing it.

Aids in Weight Loss

The high fibre content in ragi promotes satiety, curbing hunger and supporting weight management. Its low-fat content also makes it a healthy choice for weight loss diets.

Rich in Antioxidants

Ragi is a good source of antioxidants like polyphenols and flavonoids, which combat oxidative stress and lower the risk of chronic diseases.

Improves Digestive Health

Ragi's dietary fibre supports healthy digestion, helps prevent constipation, and promotes overall gut health.

Boosts Immunity

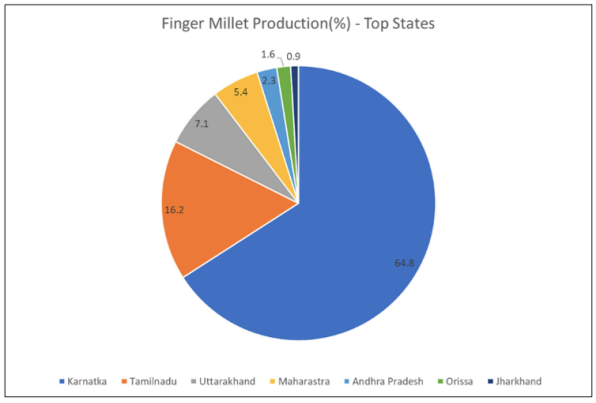
The vitamins and minerals in ragi contribute to a stronger immune system, enhancing overall health and well-being.

Finger Millets Consumption and Distribution in India

Finger millet, or *Eleusine coracana*, is primarily grown in Africa and Asia. In Africa, it is mainly grown in highland areas and marginal land where other cereals could not grow (20). The major countries are Ethiopia, Uganda, Tanzania, Kenya, and Rwanda While in Asia it is prevalent in India, Nepal, and Sri Lanka (21). Ragi, is an important staple crop in India, particularly in the southern and eastern regions. The nutritional value of Finger millet is higher than other grains. It is rich in calcium, protein, and fibre, finger millet is often considered a superfood (22). It is especially beneficial for people with lactose intolerance and is used in various health foods. Various Culinary uses of Ragi are Flour, Beverages, and Snacks (23).

The resilient nature of finger millet makes it particularly well-suited for cultivation in harsh agro-climatic conditions. Its adaptability to low-input cereal-based farming systems in Africa highlights its role in supporting traditional agricultural practices (7). With an estimated global annual planting area of 4-4.5 million hectares and a total production of 5 million tons of grains, finger millet plays a pivotal role in ensuring food security and sustenance for millions of people (13). India plays a major role in finger millet production, contributing around 2.2 million tons, with Africa following closely at approximately 2 million tons. Other South Asian countries also add to the remaining global production, underscoring the importance of this staple crop worldwide. Figure. 1 reveals that in the year 2017-18, Karnataka leads with 64.8% of the country's Ragi production, followed by Tamil Nadu at 16.2% and Maharashtra at 7.1%. Other key producers include Andhra Pradesh, Jharkhand, Odisha, Chhattisgarh, and Gujarat.

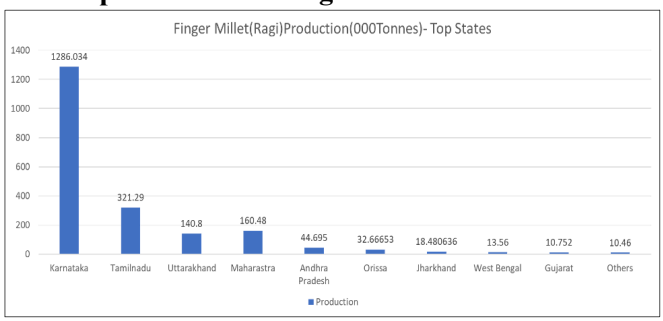
Figure 1: Shows pie chart represents top producer of finger millet



Ragi is a drought-resistant crop, well-suited for semi-arid regions, requiring minimal inputs and often cultivated as a mixed crop. Figure 2 shows that in 2018 Karnataka produces 1286.034 tonnes of Ragi while Tamil Nadu and Uttarakhand closely followed it with figure 321.29 and 140.8 Tonnes. Furthermore, it is clear that southern states namely, Karnataka and Tamil Nadu are the leading producer of Finger millet in India While Uttarakhand leads in northern states with 140.8 tonnes of Ragi with other millets (22). In India, it is cultivated over an area of 11.38 lakh hectares with total production of about 18.21 lakh tonnes and with productivity of 1601kg/hectare during the year 2015-16.

Of the total area under Finger millet Karnataka alone occupies 60% followed by Uttarakhand and Maharashtra with 10% each. Tamil Nadu has the highest productivity(2580kg/ha) followed by Karnataka(1801kg/ha) and Uttarakhand(1372kg/ha) (24).

Figure 2: Depicts graphs showing state wise production of Finger millet in Tonnes



Revival in the 21st Century

In recent years, finger millet has been rediscovered as a superfood, especially among health-conscious consumers. Its rich nutrient profile, particularly its high calcium, dietary fibre, and essential amino acids, has brought it back into focus for addressing malnutrition and lifestyle diseases like diabetes (25). With growing concerns about climate change, finger millet is increasingly valued for its ability to grow in harsh, dry conditions. Efforts are being made to promote its cultivation as a climate-resilient crop, suitable for sustainable agricultural systems. In 2023, as part of the International Year of Millets, finger millet has been spotlighted globally,

highlighting its importance for food security, particularly in regions vulnerable to climate change (26).

Discussion

Finger millet serves as a great source of carbohydrates, comprising free sugars, starch, and non-starchy polysaccharides, or dietary fibre. Its fibre content is notably higher than that of brown rice, polished rice, and other types of millet like foxtail, little, kodo, and barnyard millet. It is an abundant source of calcium, chromium, zinc, copper, and magnesium, all essential for promoting good health. Furthermore, it offers a substantial amount of non-digestible carbohydrates with a low glycaemic index, helping to prevent diabetes and cardiovascular disease. It also contributes to slowing the aging process by reducing glycosylation of proteins in the body. Ragi is an important staple crop in India, especially in the southern and eastern regions. Karnataka produces the most ragi in India, followed by Tamil Nadu and Maharashtra. Gujarat, Jharkhand, Odisha, Chhattisgarh, and Andhra Pradesh are some of the other major producers. Moreover, Millets are integral to the diets and cultures of many communities, especially in rural areas. They are often used in traditional dishes and festivals, preserving cultural heritage. Cultivating millets often involves traditional agricultural practices and knowledge, promoting biodiversity and sustainable farming methods.

Result

The nutritional profile of finger millets shows that it is rich in dietary fibre, essential amino acids, vitamins and minerals. Finger millets have low fat content and high fibre content which helps in improving digestive health. Finger millet is particularly well suited for cultivation in arid and semi-arid region due to its ability to thrive in low fertility soils and it is water efficient. overall, finger millet presents a promising solution for improving nutritional outcomes and sustainability in agriculture, particularly in regions vulnerable to climate change.

Conclusion

Finger Millets are a type of grain that provides various health benefits to the body by containing vitamins and minerals. Also, it is rich in dietary fibre, which helps to keep the digestive system healthy. It can also serve as a great alternative to rice and wheat, which is why it is regarded as one of the best grains for weight loss in India. finger millet is not only a coarse cereal but also referred as a Nutri-cereal or as a nutraceutical crop and is regarded as a potential remedy for food and nutritional security under the changing climatic conditions globally. In the past, millets were considered inferior to other cereals like wheat or rice due to their lower gluten content and ease of digestion. However, some studies suggest that millets are beneficial since they provide essential nutrients such as proteins, amino acids, insoluble fibre, and more, contributing to improved health and weight loss.

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