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Nutritional profile and Health Benefits of Super Food Ragi (Finger millet): A powerhouse of Calcium

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Abstract

Ragi or Finger millet (Eleusine coracana) is an annually cultivated crop vastly found in the regions of Asia and Africa such as in Ethiopia, India and Srilanka. It ranks as the fourth most produced millet globally. It is densely packed with many nutrients like protein, calcium, iron, and amino acids. It is rich in minerals like phosphorous, calcium and magnesium. Its rich calcium content makes it a powerhouse of Calcium. Ragi can be called as a superfood that conifers valuable health benefits such as enhancing digestion, reducing the risk of heart disease, slowing down aging, regulating diabetes etc. This study highlights the nutritional profile and health benefits of Ragi. Several factors that affect the bioavailability of calcium in ragi have also been discussed. The methods of its consumption and ways to improve the calcium absorbance from Ragi consumption has also been given. Thus, this study affirms that Ragi is a highly recommended crop to provide adequate calcium, especially for low-income groups.

Introduction

Ragi or Finger millet (Eleusine coracana) is a domesticated crop of African origin now cultivated globally. Its wild progenitor, Eleusine africana, is well-documented, and the crop was first domesticated in Africa [3]. Ecologically, finger millet likely originated from highland regions and is commonly grown in hilly areas [17]. This crop thrives in various challenging environmental conditions, making it a valuable asset in arid and semi-arid regions due to its ability to grow in low-fertility soils [7]. It serves as a staple food and is used as animal feed (straw) in industrialized nations and as food (grains) in developing countries [1]. Finger millet is especially significant in the semi-arid and arid regions of Asia and Africa [8]. It ranks as the fourth most produced millet globally, following sorghum (Sorghum bicolor), pearl millet (Pennisetum glaucum), and foxtail millet (Setaria italica) [11]. Millet grains are nutritionally superior to rice and wheat, being rich in vitamins, iron, carbohydrates, calcium (Ca), potassium, zinc, phosphorus, magnesium, and essential amino acids [16].

The finger millet grain consists of three main components: the seed coat (testa), embryo, and endosperm. It comes in various colors, including red (Figure 1), yellow, white, tan, brown, and violet, and is unique among other millets such as foxtail millet, pearl millet, kodo millet, and proso millet due to its five-layered testa, which may contribute to its higher dietary fiber content [2]. The crop's drought resistance is potentially linked to its high antioxidant content. In developing countries, there is significant potential to transform millet grains into value-added foods and beverages [4].

Figure 1: Red Ragi

Nutritional profile of Ragi

Finger millet is a significant cereal widely consumed in Africa and Asia, primarily by subsistence farmers and impoverished rural communities. Known for its nutrient-rich seeds, finger millet provides essential energy and nutrients to these populations. Remarkably, its calcium content is ten times

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higher than that of other cereal crops. Finger millet's robust resistance to both biotic and abiotic stresses, along with the long shelf-life of its seeds, positions it as a vital crop for the future. Although it was overlooked during the first Green Revolution, its rich nutrient profile and climate resilience have recently drawn the attention of researchers, including those in Western countries. Finger millet is highly nutritious and is used as a food source (grains) in developing nations and as animal feed (straw) in developed countries, which has led to its perception as "poor man's food" [18]. Calcium is essential for various regulatory functions in the human body, including nerve impulse transmission, muscle contraction and relaxation, blood coagulation, enzyme activation, and hormone secretion [13].

Major cereal crops typically do not provide adequate calcium for low-income populations. In contrast, finger millet has a significantly higher calcium content, with 344 mg per 100 grams, which is about ten times that of wheat (41 mg/100 g), maize (26 mg/100 g), and rice (33 mg/100 g), and three times higher than milk [10]. Thus, finger millet is a prime example of a calcium-rich crop in the developing tropical and subtropical regions. In addition to calcium, finger millet grains are richer in minerals such as phosphorus, iron, and manganese compared to other cereals [10]. Historically valued as a health grain, finger millet, also known as Ragi, has often been overshadowed by the widespread availability of other cereals like rice and wheat. However, recent research and initiatives to combat malnutrition by incorporating millets into daily diets have boosted Ragi's popularity [19]. Renowned as a superfood, Ragi is high in protein, calcium, iron, and amino acids. It is also beneficial for infants, making it a common ingredient in baby porridge [19]. Health Benefits of ragi as a supplement of Calcium Calcium (Ca) is the fifth most abundant element in the human body, constituting up to 1.9% of adult body weight [13]. It plays crucial roles in providing rigidity and structure, mediating vascular and muscular contractions or dilations, and transmitting nerve signals.

Despite its importance for health and wellbeing, the World Health Organization (WHO) estimates that low dietary calcium intake is prevalent worldwide. This deficiency poses a significant global risk, particularly in underdeveloped regions. However, the lack of reliable and practical indicators in these areas results in insufficient data, complicating efforts to assess the true global prevalence of calcium deficiency. Recent estimates, based on food supply data, indicate that 3.5 billion people were at risk of calcium deficiency in 2011, with approximately 90% of those affected residing in Africa and Asia. Many of these regions have agriculture-based economies, and large segments of their populations rely on locally grown produce to meet their calcium needs. In such contexts, it is highly recommended to promote staple crops that provide adequate calcium, especially for low-income groups. One such calcium-rich, traditional, and locally well-adapted crop is finger millet.

Ragi is exceptionally rich in calcium because of which it can be called as a power house of calcium which is vital for bone development and maintenance. It plays a key role in preventing osteoporosis and strengthening bones, particularly in growing children and older adults [16]. Calcium is also essential for the development and maintenance of strong teeth, helping to fortify tooth enamel and prevent dental caries (cavities). Phosphorus works in conjunction with calcium to form and maintain tooth structure. Additionally, magnesium, another mineral present in Ragi, is crucial for the formation of tooth enamel and supports the structural development of teeth and bones [9].

Methods of Ragi Consumption

Ragi can be processed in the form of flour that can be used in making various staple dishes like rotis, idlis, upma, parathas etc. from it. It can also be used alone or mixed with urad daal to make delicious fried spreads called Ragi dosas. It can also be consumed in the form of porridges, soups etc. Ragi flour can be added to all-purpose flour to make crunchy Ragi biscuits. It can also be consumed in the form of sweets like halwa, barfi and laddus. A best way to have Ragi is in the form of a simple malt, by heating it with some milk and jaggery, which serves as a wholesome breakfast drink. Some foods prepared from Ragi are given in Figure 2.

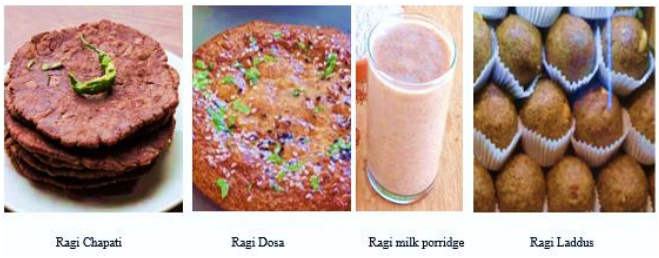

Figure 2: Some foods prepared from Ragi

Health benefits of Ragi

Digestive Health: Ragi is rich in dietary fiber, particularly insoluble fiber, which promotes digestive health by adding bulk to the stool and facilitating regular bowel movements, thus preventing constipation. This insoluble fiber also supports the growth of beneficial gut bacteria, enhancing overall digestive well-being. Additionally, the fiber content in Ragi slows down the digestion process, leading to a gradual release of glucose into the bloodstream. This is particularly beneficial for individuals with diabetes, as it helps manage blood sugar levels [6].

Weight Management: The high dietary fiber content in Ragi, especially insoluble fiber, contributes to a feeling of fullness, which can help control appetite and support weight management efforts.

Antioxidant Properties: Ragi contains significant levels of antioxidants, such as polyphenols, which combat oxidative stress. [15] These antioxidants protect cells from damage

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caused by free radicals, thereby reducing the risk of chronic diseases such as cancer, cardiovascular diseases, and conditions related to aging.

Gluten-Free: Naturally gluten-free, Ragi is an excellent dietary choice for individuals with celiac disease or gluten intolerance [13]. 74 | The Millets Revolution - The Miracle for Human Health

Nutrient-Rich: In addition to its high calcium content, Ragi is rich in iron, phosphorus, and B-vitamins. These nutrients are essential for various bodily functions, including red blood cell production, energy metabolism, and maintaining a healthy nervous system.

Bioavailability of Calcium in Ragi

Determining the efficacy and biological impact of finger millet on improved nutrition and health is challenging, primarily due to the bioavailability of calcium (Ca) in its seeds. Bioavailability refers to the extent to which an ingested, digested, and absorbed nutrient reaches systemic circulation and positively impacts health. Ideally, Ca bioavailability should be assessed through in vivo human studies. It is well established that less than 30% of consumed Ca is effectively absorbed [20]. However, in vitro bio accessibility methods have shown that uncooked finger millet has a higher Ca bioavailability, with 36.6% soluble and 28% dialyzable Ca. These values surpass those of other staple cereals such as rice (30.4% soluble Ca; 24.7% dialyzable Ca), sorghum (31.9% soluble Ca; 26.0% dialyzable Ca), and maize (25.4% dialyzable Ca). Thus, finger millet is a more effective source of bioavailable Ca compared to many other staple cereals. Enhancing its nutritional profile through biofortification could further mitigate Ca deficiency. Nonetheless, the actual bioavailability of Ca from finger millet is influenced by various other factors, posing additional challenges.

Factors influencing the bioavailability of calcium in Ragi

Several factors affect the bioavailability of calcium in Ragi:

Phytates: Ragi contains phytic acid, which can bind to calcium and form insoluble complexes, thereby reducing calcium absorption. Phytates are commonly known to inhibit mineral absorption in many plant-based foods.

Oxalates: Although Ragi is not particularly high in oxalates compared to certain leafy greens, oxalates can still impact calcium absorption by forming insoluble calcium oxalate.

Dietary Fibers: The high fiber content in Ragi can negatively influence calcium absorption by trapping calcium within the fiber matrix, preventing its absorption in the intestines.

Other Nutrients: The presence of other nutrients, such as magnesium and phosphorus, in Ragi can affect calcium absorption. Maintaining an appropriate balance between these nutrients is essential for optimal calcium absorption. Absorption and Utilization Comparison of Calcium Absorption from Ragi with other Calcium rich foods Ragi (finger millet) is recognized for its high calcium content, with approximately 344 mg of calcium per 100 grams.

However, the bioavailability of calcium from Ragi is influenced by several factors, which can differ significantly from other calcium-rich foods.

1. **Ragi vs. Dairy Products**: Dairy products, such as milk and cheese, are known for their high calcium absorption rates, largely due to the presence of lactose and casein which enhance calcium absorption. Studies indicate that calcium absorption from dairy can be as high as 30-35%.
2. **Ragi vs. Leafy Greens**: Green leafy vegetables like kale and broccoli also provide a good source of calcium, though absorption rates can vary. For example, calcium absorption from broccoli is around 50-60%, but from spinach, it's lower (about 5%) due to the presence of oxalates which inhibit calcium absorption.
3. **Ragi vs. Fortified Foods**: Fortified foods (e.g., calcium-fortified orange juice) often contain added calcium in a form that is easily absorbed. The absorption rate from these foods is similar to that from dairy products.

Methods to enhance Calcium Absorption in Ragi

Fermentation: Fermentation of Ragi can significantly reduce the phytate content, thereby enhancing the bioavailability of calcium. Fermentation involves natural processes that break down phytic acid, making calcium more available for absorption. Research has shown that fermentation can increase calcium absorption by up to 20- 30%.

Sprouting: Sprouting is another effective method to enhance calcium bioavailability. During the sprouting process, enzymatic activities increase, which leads to the degradation of antinutritional factors like phytates. Studies have demonstrated that sprouting can improve calcium absorption by 15- 25%. Sprouted Ragi are shown in Figure 3.

Figure 3: Ragi Sprouts

Soaking: Soaking Ragi before cooking can also help reduce the phytate content

Combining with Vitamin D: Vitamin D enhances calcium absorption in the intestines. Consuming Ragi along with foods rich in vitamin D or through adequate sun exposure can improve the bioavailability of calcium [5].

Conclusion

Finger millet, known for its high calcium content, offers superior calcium bioavailability compared to other staple foods. This characteristic contributes to higher calcium retention and reduced bone resorption, making finger millet particularly beneficial for children, the elderly, and women. Household processing techniques such as germination and fermentation can further enhance the bioavailability of calcium in finger millet. The promising health benefits suggest that incorporating finger millet into diets could support bone health and overall well-being. However, this field of research, despite having ancient roots, is still emerging. Therefore, further studies are essential to substantiate these findings and to develop science-based dietary recommendations. Generating robust evidence on finger millet's potential to improve bone mineral mass and other bodily functions is crucial for promoting its integration into nutritional programs and everyday diets.

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References

[1] Antony Ceasar, S., Maharajan, T., Ajeesh Krishna, T.P., Ramakrishnan, M., Victor Roch, G., Satish, L. and Ignacimuthu, S., 2018. Finger millet [Eleusine coracana (L.) Gaertn.] improvement: current status and future interventions of whole genome sequence. Frontiers in plant science, 9, p.382118.

[2] Banerjee, P., Maitra, S. and Banerjee, P., 2020. The role of small millets as functional food to combat malnutrition in developing countries. Indian Journal of Natural Sciences, 10(60), pp.20412-20417.

[3] Chandra, D., Chandra, S. and Sharma, A.K., 2016. Review of Finger millet (Eleusine coracana (L.) Gaertn): A power house of health benefiting nutrients. Food Science and Human Wellness, 5(3), pp.149-155.

[4] Chandrasekara, A. and Shahidi, F., 2010. Content of insoluble bound phenolics in millets and their contribution to antioxidant capacity. Journal of agricultural and food chemistry, 58(11), pp.6706-6714.

[5] Gibson, R.S. and Hotz, C., 2001. Dietary diversification/modification strategies to enhance micronutrient content and bioavailability of diets in developing countries. British Journal of Nutrition, 85(S2), pp. S159-S166.

[6] Giuntini, E.B., Sardá, F.A.H. and de Menezes, E.W., 2022. The effects of soluble dietary fibers on glycemic response: an overview and futures perspectives. Foods, 11(23), p.3934.

[7] Gull, A., Jan, R., Nayik, G.A., Prasad, K. and Kumar, P., 2014. Significance of finger millet in nutrition, health and value-added products: a review. Magnesium (mg), 130(32), p.120.

[8] Krishna, T.A., Maharajan, T., Roch, G.V., Ramakrishnan, M., Ceasar, S.A. and Ignacimuthu, S., 2020. Hybridization and hybrid detection through molecular markers in finger millet [Eleusine coracana (L.) Gaertn.]. Journal of Crop Improvement, 34(3), pp.335-355.

[9] Kumar, A., Kumari, P. and Kumar, M., 2022. Role of millets in disease prevention and health promotion. In Functional Foods and Nutraceuticals in Metabolic and Non- Communicable Diseases (pp. 341-357). Academic Press.

[10] Kumar, A., Metwal, M., Gupta, A.K., Puranik, S., Singh, M., Gupta, S., Babu, B.K., Sood, S. and Yadav, R., 2016. Nutraceutical value of finger millet [Eleusine 78 | The Millets Revolution - The Miracle for Human Health coracana (L.) Gaertn.], and their improvement using omics approaches. Frontiers in plant science, 7, p.198656.

[11] Maharajan, T., Ceasar, S.A., Krishna, T.P.A. and Ignacimuthu, S., 2019. Phosphate supply influenced the growth, yield and expression of PHT1 family phosphate transporters in seven millets. Planta, 250, pp.1433-1448.

[12] Moreno Amador, M.D.L., Comino Montilla, I.M. and Sousa Martín, C., 2014. Alternative grains as potential raw material for gluten–free food development in the diet of celiac and gluten–sensitive patients. Austin Journal of Nutrition and Metabolism, 2 (3), 1-9.

[13] Nordin, B. E. C. (1976). In: Nordin B. E. C. (Ed.), Calcium, Phosphate and Magnesium Metabolism. Churchill Livingstone, London.

[14] Pravina, P., Sayaji, D. and Avinash, M., 2013. Calcium and its role in human body. International Journal of Research in Pharmaceutical and Biomedical Sciences, 4(2), pp.659-668.

[15] Rice-Evans, C., Miller, N. and Paganga, G., 1997. Antioxidant properties of phenolic compounds. Trends in plant science, 2(4), pp.152-159.

[16] Sahaya Rani, G., Swaminathan, A. and Vijayaraghavan, R., 2021. Effectiveness of Physical Activity and Finger Millet-Based Food Supplement on Biochemical Parameters and Bone Mineral Density among Premenopausal Women. Evidence-Based Complementary and Alternative Medicine, 2021(1), p.4757991.

[17] Saleh, A.S., Zhang, Q., Chen, J. and Shen, Q., 2013. Millet grains: nutritional quality, processing, and potential health benefits. Comprehensive reviews in food science and food safety, 12(3), pp.281-295.

[18] Upadhyaya, H.D., Gowda, C.L.L. and Reddy, V.G., 2007. Morphological diversity in finger millet germplasm introduced from Southern and Eastern Africa. Journal of SAT Agricultural Research, 3(1), pp.1-3.

[19] Vijaykumar, V. 2021. The Unmissable Benefits & Uses of Ragi For Health. The New Indian Express, Chennai. 5.5.2021 19. Wambi, W., Otienno, G., Tumwesigye, W. and Mulumba, J., 2021. Genetic and genomic resources for finger millet improvement: opportunities for advancing climate-smart agriculture. Journal of Crop Improvement, 35(2), pp.204-233.

[20] Heaney, R. P. (2006). Calcium intake and disease prevention. Arquivos Brasileiros de Endocrinologia & Metabologia, 50(4), 685–693. https://doi.org/10.1590/S0004-27302006000400004

Declarations:

Authors' Contribution:

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- Data collection, interpretation, and drafting of manuscript
- The author agrees to take responsibility for every facet of the work, making sure that any concerns about its integrity or veracity are thoroughly examined and addressed

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