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Unlocking The Nutritional Potential Of Finger Millet (Ragi, *Eleusin coracana L.)* : A Review

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Abstract: Millets, recognized as superfoods, possess high nutritional value compared to other cereals. Finger millet, also known as ragi in India, is extensively cultivated, particularly in South India, serving as a staple food for many rural populations. Ragi is rich in nutrients and offers advantages as an endurance crop due to its numerous essential amino acids. Its high dietary nutritional content provides various health benefits, including reducing blood glucose levels, aiding in celiac disease management, reducing anemia, and exhibiting anti-cancer, anti-inflammatory, anti-bacterial, and antioxidant properties. Despite its potential, ragi's diverse culinary applications are often overlooked due to insufficient awareness. This review focuses on ragi's health benefits, nutritional value, traditional uses, and methods for value addition, promoting its incorporation into modern diets and culinary practices.

Index Terms **-** Finger millet, Ragi, antioxidant, nutrients, health benefits, traditional uses, value addition.

I. INTRODUCTION

Eleusine coracana, the scientific name for ragi, is an ancient millet that is rich in nutrients and is grown extensively in India and some regions of Africa. Because of its remarkable health advantages and capacity to thrive in harsh, arid environments, it is a staple diet in many countries. Because of its high concentration of vital elements like protein, dietary fibre, calcium, iron, and antioxidants, ragi is regarded as a superfood. Because it is naturally gluten-free, it is a good option for those who have coeliac disease or gluten sensitivity (Vijayabharatai *et al*., 2003).

Ragi's high calcium content, which promotes strong bones and prevents osteoporosis, is one of its main nutritional benefits. It is also a rich source of complex carbs with a low glycemic index and helps regulate blood sugar, both of which are advantageous for diabetics. Because it prolongs feelings of fullness, dietary fiber helps with digestion, intestinal health, and weight control. Furthermore, ragi has important amino acids, such as methionine, which are uncommon in other grains and support the general well-being of tissues and muscles (Purma *et al*., 2013).

Ragi is used in many traditional and contemporary cuisines and is a very flexible ingredient in cooking. It can be added to baked products like bread and cookies or eaten as rotis, dosas, idlis, or porridge. Ragi is becoming more and more well-known throughout the world as a sustainable and healthful dietary option due to its remarkable nutritional profile and health advantages. (Soni *et al*., 2017).

II. NUTRIENT COMPOSITION OF FINGER MILLET

Finger millet is rich in micronutrients, such as vitamins and minerals. It is the most prevalent source of calcium. According to the data, finger millet has a macronutrient profile of 72.6% carbs, 1.3% fat,7.3% protein, 19.1% dietary fiber, 3.6% crude fiber, and 3% minerals (Jagati *et al*., 2021).

2.1 Carbohydrates

Finger millet is composed of a high content of carbohydrates with 1.04% free sugars, 11.5% non-starchy polysaccharides or dietry fiber and 65.5% starch (A. Deaton, J Dreze., 2009). The dietary fiber content of finger millet (11.5%) is much higher than the fiber content of polished rice, brown rice, and all other millets such as foxtail, little, kodo, and barnyard millet. In ragi, 59.4-70.2% of carbohydrate is present in the form of starch, which is considered as the main constituent (P. Jagati *et al*., 2021). The finger millet sarch comprises amylose amylopectin (S. Shobana *et al*., 2013). The non-starch polysaccharide occupies 20-30% portion of total carbohydrate present in Finger millet (Nirmala *et al*., 2000).

2.2 Proteins

The protein percentage is between 4.9% and 11.3% (P. Jagati et al., 2021). The average protein content is about 7.3% that is on par with that of rice, i.e., 7.9% (Diabetes fact sheet., 2021).

Prolamins and glutelin are the primary components of the protein in finger millet. The nutritional level is well balanced in finger millet compared to other millets. Fingers of millet possess approximately 44.7 percent of essential amino acids (Mohamed TK *et al*., 2009).

Eleusinin, the critical protein content prevailing in finger millets, holds very high percentage contents of cystine, tryptophan, methionine, along with other aromatic acids, is accountable for developing and enhancing growth of human health, and other grains or millets are unable to provide. Methionine percentage is high in finger millet whose value is around 5% of total protein (WHO report.,2021). Finger millet contains a higher level of sulfur-containing amino acids, namely methionine and cysteine, compared to milled rice (S. Shobana *et al*., 2013).

2.3 Fats

Finger millet boasts a notable lipid profile, comprising a harmonious blend of linoleic, palmitic, and oleic acids, with a total lipid content of approximately 5.2%, and a free lipid content of around 1.5% (Mohamed TK *et al*.,2009). According to the fatty acid outline, saturated fatty acids make up 25.6%of all Whereas unsaturated fatty acids make up the majority 74.4% (Sridhar R *et al*., 1994).

III. MICRONUTRIENTS

3.1 VITAMINS AND MINERALS

Finger millet exhibits a remarkably high ash content compared to other cereal grains, rendering it an excellent source of essential minerals. Specifically, it is rich in iron, magnesium, sodium, phosphorus, copper, and potassium. The germ, aleurone layer, and pericarp of the finger millet are particularly dense in minerals, making them the most nutrient-rich components (P. Jagati *et al*., 2021).

Millets are known for their exceptionally high vitamin B content, which suggests that they could be a plentiful source of this essential nutrient. It's interesting to note that finger millet contains 0.2–1.0 micrograms of beta-carotene. Also includes vitamin E (Ray *et al*., 2016). Further more, water-soluble vitamins like thiamine, niacin, riboflavin, vitamin C, and tocopherols (vitamin E) are abundant in finger millet. The germ and aleurone layer of finger millet are very rich in water-soluble vitamin B. However, the abundance of lip-soluble vitamins in the germ of finger millet highlights its nutrient-dense profile (Jaybhaye RV *et al*., 2014).

3.2 Fiber

- The fiber content in finger millet is believed to enhance the bioavailability of calcium, supporting immune system development. It also exhibits anti-cancer properties, particularly in reducing the risk of colon cancer. A daily diet rich in fiber is recommended, with suggested intake levels of 38g for men and 25g for women. Finger millets have a high fiber content, which is primarily concentrated in the walls of the endosperm and pericarp (P. Jagat *et al*., 2021)

3.3 Composition of Ragi millets, Rice and Wheat (per 100 g edible portion, 12% moisture Content)

Table 3.3 **Composition of Ragi millets, Rice and Wheat (Gull et al., 2014)**

Sr.no	Particulars	Ragi	Rice	Wheat
1	Carbohydrates (g)	72.6	78.2	71.2
2	Protein (g)	7.7	6.8	11.8
3	Fat(g)	1.5	0.5	1.5
4	Crude fibre(g)	3.6	5.2	12.9
5	Ash(g)	2.7	0.6	1.5
6	Calcium (mg)	344	10	41
7	Phosphorus (mg)	250	160	306
8	Iron (mg)	6.3	0.5	3.9
9	Manganese (mg)	3.5	1.0	13.3
10	Magnesium(mg)	130	3.2	120

IV. VALUE ADDED PRODUCTS FROM FINGER MILLET

It is a fantastic alternative to other grains like rice and other starchy grains and can be utilized in a multitude of ways. The following section discusses some instances of value-added goods and the potential use of this small millet as a fundamental ingredient.

4.1 Chapatti (Roti)

When preparing chapatti (roti), a 7:3 ratio of wheat to finger millet is appropriate. The production of visually appealing chapattis remains unaffected, even if this recommended blend contains less gluten. Additionally, the chapatti's color becomes somewhat darker. Finger millet fortification not only improves the taste of chapatti's but also helps diabetics control their blood sugar levels. We feel fuller and consume fewer calories because the fibers are thicker and break down more slowly, which may help us avoid overindulging in food. Additionally, finger millet's high fiber content benefits those who have constipation (Gull *et al*., 2014).

4.2 Puffing

Puffing is one of the popular traditional methods done in case of millets. A RTE product with a pleasant texture and enticing flavour is popped millet and it's flour. This process improves the nutritional value by inactivating some of the anti- nutritional factors and thereby enhancing the protein and carbohydrate digestibility. (Nirmala M. *et al*., 2000). Finger millet (ragi) grains are puffed to create a versatile ingredient for ready-to-eat foods. The grains are first conditioned with water and tempered, then puffed by agitating them on hot sand or using modern air puffing machines. This process improves the grain's appearance, color, flavor, and scent, and enhance shelf life. The puffed grains can then be ground into flour and used in various RTE food preparations (Gull *et al*., 2014) .

4.3 Important value added products of Finger Millet / Ragi.

Table 4.3 **Value added products (Krishi Vigyan Kendra , Dantevada, I.G.K.V. , Raipur C.G)**

Sr.no	Name of Ragi Products	Ingredients
1	Multi-grain flour	Cleaned finger millet seed (30%) and cleaned wheat seed (70%)
2	Ragi Malt – Weaning food	Sprouted finger millet seed (70%) and sprouted green gram seed (15%) and chickpea sprouted seed (15%)
3	Ragi Cake	Flour of finger millets& wheat, milk powder, dry fruits, soda, vanilla accence, katri, baking soda, sugar
4	Ragi Anrasa	Flour of finger millets & rice, sesamum, dry coconut, molasses
5	Ragi Shakkarpara	Flour of finger millets & wheat, rawa of wheat, sugar and clarified butter

5.1 Antidiabetic properties

In order to manage diabetes and avoid chronic vascular problems, it is crucial to eat meals high in fiber and complex carbs to avoid abrupt spikes in blood glucose. Finger millet's carbohydrates are said to be absorbed and metabolized at a substantially slower rate. The cereal grain's high dietary fiber and polyphenol levels are mostly responsible for these health advantages, since they have been linked to a lower prevalence of gastrointestinal diseases and diabetes mellitus (Kavitha *et al*., 1995).

5.2 Antioxidant Activity

Antioxidants are highly prized for their lipid stabilizing ability to prevent excessive oxidation. The seed coat of finger millet is rich in polyphenols, flavonoids, and tannins. These have a number of roles. These are metal chelators, singlet oxygen quenchers, and reducing agents. Phenolic compounds present in millet donate hydrogen atoms to free radicals and hence contribute to its antioxidant property. This produces a more stable and less reactive phenoxyl radical. Edible flours of small millets inherently contain these beneficial endogenous antioxidants (Asharani *et al*., 2013).

5.3 Antimicrobial Effects

The phenolic compounds of finger millet, mainly tannins, can give natural resistance to fungal infections. These compounds present a structural barrier in the outermost layer of the grain that prevents the growth of fungi. Because of the high polyphenol content in the seed coat, acidic methanol extracts of finger millet exhibit stronger antifungal and antibacterial properties than whole wheat extracts (Hegde *et al*., 2002).

5.4 Natural Weight Loss

This food item is naturally very rich in dietary fiber content and tryptophan-a significant contributor for the purpose of weight management. Dietary fiber takes its time, causing the person to feel 'full' thereby lowering the intakes of caloric value inside the body by delaying gastric empting. From a metabolic standpoint, this function prevents the accumulation of much fat, especially in the abdominal region, where it tends to accumulate because of insulin resistance. (Gull *et al*., 2014).

5.5 Strenghthens Bones

This food is a rich calcium source and contains about 344 mg per serving. It basically lays a very vital role in strong bones and prevention of diseases such as osteoporosis. Calcium is the major mineral in bone tissue, which starts from infancy to old age for proper skeletal development. Other minerals such as magnesium and phosphorus are present to increase calcium and bone mineral density absorption. According to studies, a diet low in calcium results in brittle bones, joint pains, and susceptibility to fractures (Romee *et al*., 2014).

5.6 Blood Pressure Regulation

This diet enhances vascular relaxation and arterial flexibility, two important components of stable blood pressure, because of its low glycemic index and high fiber content. By ensuring smooth blood flow, aortic elasticity lowers the risk of cardiovascular disease and hypertension. Potassium and magnesium help to reduce salt retention, a key cause of high blood pressure (Upadhyaya *et al*., 2006).

5.7 Disease Protection

This food possesses strong anti-inflammatory, antiviral, anticancer, and platelet aggregation inhibitory properties, and is a potent natural protector against several diseases. Inflammation is the precursor to most chronic conditions, such as arthritis, diabetes, and heart disease. The bioactive compounds in this food, which include flavonoids and tannins, inhibit inflammatory pathways and thus diminish the risk of chronic inflammation-related disorders (Chethan *et al*., 2007).

5.8 Enhances Hemoglobin in Children

This dish is very helpful for promoting good hemoglobin levels in youngsters because it is a great source of calcium and iron. Hemoglobin, a protein found in red blood cells that carries oxygen throughout the body, depends critically on iron. In growing children, an iron deficiency causes anemia, exhaustion, and impaired cognitive development (Tatala *et al*., 2007).

5.9 Imoroves Digestibility

This food's slow rate of digestion is one of its remarkable qualities, making it a great nutritional option for pregnant women and diabetic patients. In order to avoid abrupt spikes and crashes in blood sugar levels, slow digestion guarantees a sustained release of energy. This constant energy source is essential for sustaining stamina and avoiding exhaustion, particularly during pregnancy when metabolic needs are elevated (Watt *et al*., 1962).

5.10 Boosts Lactation

A nursing mother requires higher intake of necessary nutrients like amino acids, calcium, and iron to assist milk production, and therefore ensures adequate nutrition of her infant. This food naturally has these nutrients, making it ideal for the postpartum period and assisting lactation support (Geneva *et al*., 1985).

5.11 Reducues Tumor Risk

This food is rich in bioactive compounds like phytates, phenols, and tannins. These compounds exhibit strong anti-cancer properties that help inhibit abnormal cell growth,reduces cholesterol, and regulates blood pressure. This reduces the risk of metabolic disorders and tumor formation (Taylor *et al*., 2017).

CONCLUSION

Considering as finger millet is a warming grain that aids in body heating during cold or wet weather, it is regarded to be among the less inflammatory but also most edible grains on the market. Its grain's outer layer has high fibre content. People should be made aware of the nutritious content and health advantages of finger millet and the foods prepared from it. Analysing all cereal grains, it was determined to have the best nutritional and functional qualities.

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