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Eleusine coracana: Disease Curing Superfood- A Review

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Abstract: Finger millet (Eleusine coracana) being a staple food found in different parts of India and abroad is promoted as an extremely healthy food. The nutraceutical importance of this minor millet lies in its content of dietary fiber (soluble & insoluble) and other protective healthy nutrients such as calcium, iron, phytates, phenolic compounds, carbohydrates, trypsin inhibitor factors, and moreover sources for thymine, riboflavin, and important amino acids including methionine, isoleucine, leucine, phenylalanine, which are deficient in other starchy meals.

It is hence known for several health benefits such as antioxidant, antimicrobial, anti-diabetic, anti-inflammatory, anti-diarrheal, anti-tumorigenic, antiulcer, and atherosclerogenic effects. Regular use of finger millet reduces malnutrition, treats degenerative disorders, and delays the onset of early ageing. Finger millets are extremely nutrient rich and have been shown to be helpful for preserving excellent health.

Hence it makes it a component of dietary and nutritionally balanced food which can be consumed regularly in various dishes; and it can be processed through different processing methods like soaking, fermentation, roasting, popping, or malting, and in form of composite flour, instant food mixes, extruded or bakery products, and other value-added products. Its products' consumption aids in the management of body illnesses and shows positive effects on health.

The consumption pattern and popularization of such readily digestible, highly nutritious, and versatile millet is essential in a broader range.

Due to its enormous potential benefits enhancing nutritional quality of population act as a tool to halt the global pandemic of lifestyle diseases.

Keywords: health, disease, nutritious, finger millet

I. INTRODUCTION

Due to increased resilience to pests, diseases, and their superior adaptation to a variety of environments, millets are significant but underutilized crops in tropical and semiarid parts of the world. Considering its high output yield, which can tolerate levels of salt, a brief growing season, drought tolerance, resistance to water logging, requiring little inputs during growth, and due to rising global population and dwindling water resources represent crucial crops for human usage in the future. (Chandra D *et al.*, 2016). Small millets currently make up less than 1% of the food grains produced worldwide (ICAR, 2010). Millets are small, seeded grasses that are grown all over the world as cereal grains or crops.

These tiny, seeded plants are utilized as fodder or human food and belong to an agronomic functional category tropical area of Africa and Asia that is semi-arid millets are produced with 97% productivity mostly in Nigeria and India beneficial under hot, dry conditions, and these crops only need a little quantity of water. Millets come in a variety of forms, and they each have distinctive nutritional profile characteristics, value, and texture. (P Jagati *et al.*,2021) The plant *Eleusine coracana*, sometimes referred to as African millet or finger millet belongs to the Magnoliophyte family. Finger millets are classified under family *poaceae*. Ragi or finger millet is experiencing a shallow, branching, and fibrous root structure that roots at reduced nodes. The radical pierces the ragi grain as it grows its way out and creates lateral roots as well as seminal roots the seminal root forms as the seedlings develop. Basal nodes give birth to fibrous roots. As soon as seedlings, most of the roots are turned off when they are pulled out, but shortly fresh roots emerge. (Vetriventhan *et al.*, 2016) Finger millet commonly known as ragi, is an excellent source of carbohydrates, protein, dietary fiber, and minerals. (Thapliyal *et al.*, 2015)

It is a vital staple meal for individuals in poor socioeconomic groups and for those with metabolic diseases like diabetes and obesity. According to research, consuming whole grains and cereal fiber is inversely related to BMI, waist circumference, total cholesterol,

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metabolic syndrome, cardiovascular disease mortality, insulin resistance, and type 2 diabetes incidence. (S Shobana *et al.*, 2013) Additionally, millets are recommended for celiac sufferers because they do not contain gluten. (Chandrashekara *et al.*, 2010)

Table 1.1 Nutritional Value

Calcium	0.38%
Protein	6-13%
Dietary Fiber	18%
Carbohydrates	65-75%
Minerals	2.5-3.5%
Phytates	0.48%
Tannins	0.61%
Phenolic compounds	0.3-3%

(D Chandra *et al.*, 2016)

A. Nutritional Significance

Typically, the whole grain of finger millet as well as the seed coat which is rich in nutritional fiber and minerals are processed into flour for consumption among different areas. Ragi consists of tannins in the seed coat layers which might contribute to the drying of products made from it. There is a significant amount of millet seed coat, germ, and endosperm cell containing polyphenols walls. (A. Vagdevi *et al.*, 2023) Amount of protein differs according to the varieties of ragi. Prolamins make up the bulk of the protein in finger millet. Cereals and millets often have lower lysine content, but finger millet has 0.400g isoleucine per 100g which is necessary for tissue formation and growth. (ICMR, 2010) Additionally, it helps in regulation of glucose. (Van Loon, 2012)

A crucial aromatic amino acid, phenylalanine is a direct precursor of the neuromodulator which accounts for 0.310g per 100g. Phenylalanine causes a genetic disorder called hydroxylase deficiency. It is autosomal recessive that results in sensitivity to the crucial amino acid diet containing phenylalanine. (Friedman, 2018) The amount of calcium and phosphorus in finger millet is 398mg & 320mg respectively. The element calcium (Ca) is essential for the body's growth and maintenance of healthy bones; it prevents hypertensive disorders, blood pressure and colorectal adenomas. (Cormick and Belizán, 2019) Phosphorus (P) is a mineral found in bones and teeth. In normal adults, the deficiency of phosphorus leads to calcium deprivation hypercalciuria and hypercalcemia (Takeda *et al.*, 2012). Folic acid is available in various ragi based food products. Total folic acid present in finger millet is 18.3µg. Folic acid intake reduces both the occurrence and the recurrence of neural tube defects; FA is the synthetic form of folates (Takeda *et al.*, 2012).

B. Health Properties of Finger Millet

One of the minor grains, ragi has several health advantages, some of which are linked to the plant's high levels of dietary fiber and polyphenols. For those in lower economic brackets in India it is a staple meal that is crucial for the survival of humans. Its significant nutritional value is acknowledged due to its high calcium (0.38%), dietary fiber (18%), and phenolic compound (0.3–3%) content. Its anti-diabetic, anti-tumorigenic, anti-atherosclerogenic, antioxidant, and antibacterial qualities are among many other well-known health benefits. (Devi *et al.*, 2014)

Table 1.2 Health benefits of Finger Millet

Nutrient	**Health Benefits**
Calcium (Ca)	• Helps in muscle building along with synthesis of blood cells
Phosphorus (P)	• It is a component of bone cell matrix and supports energy processing in DNA
Iron (Fe)	• Iron is main component of hb which regulates RBCs formation and plays major role in prevention of anemia
Magnesium (Mg)	• It is a component of bone matrix and helps in the synthesis of ATP
Sodium (Na)/ Potassium (K)	• Sodium/Potassium are electrolytes which are essential in regulation of ATP
Chromium (Cr), Copper (Cu), Magnesium (Mn), Zinc (Zn), Molybdenum (Mo)	• These are the catalyzing agent in several physiological reactions like lipid metabolism & glucose metabolism
Vitamin B1 (Thiamine), Vitamin B2 (Riboflavin), Vitamin B3 (Niacin)	• They are responsible for many nutraceutical properties like anti-ageing, antioxidant, anti-inflammatory, anti-cancer
Vitamin E (Tocopherol)	• Promotes eye health in response to vision
Total Folic Acid	• Folic acid acts as precursor for formation and utilization of iron

(Kumari and Morya,2021; Jagati *et al.*, 2021; Godswill *et al.*, 2020; Grasso *et al.*, 2020; Ramashia *et al.*, 2018; M Suwannasom *et al.*, 2020; Penberthy *et al.*, 2020; Eshak and Arafa 2018; Chandra *et al.*, 2016; Kumar *et al.*, 2016; Morya *et al.*, 2015; Shobana *et al.*, 2013)

1) Anti- Diabetic

The most common cause of illness and death is diabetes mellitus (DM), and the disease's prevalence is rising daily. Dietary changes, particularly the addition of ragi can help prevent and manage diabetic mellitus. (Aggarwal *et al.*, 2023)

Dietary bioactive substances such dietary fibers and polyphenols are abundant in finger millet grains. The gut bacteria in the colon further breaks down these molecules into beneficial compounds including SCFAs and small-chain phenolic acids. Finger millet is specifically enhanced with microbiota-accessible substances (polyphenols and prebiotics) that the host's gut flora metabolizes and benefits from.

It has been shown that prebiotics and polyphenols help manage diabetes and its co-morbidities, which include low-grade inflammation, obesity, and blood glucose management. (Singh *et al.*, 2022)

2) Anti-inflammatory

Plant-based antioxidants such flavonoids and phenolic compounds have a wide range of biological effects. Antioxidants are important in lowering lipid peroxidation which is a process linked to aging and cancer.

The whole grain millet is edible and in many Asian and African nations whole meals are used in traditional cooking preparations. This suggests that the phytochemicals found in millets, including polyphenolic compounds, are safe to eat and do not pose a health risk to humans.

These polyphenolic compounds are antioxidant, antiaging, and possess other nutraceutical qualities and have drawn a lot of attention. Their amount and composition vary depending on the kind of millet grain. (Kumar *et al.*, 2021)

3) Anti-microbial property

The exterior layers of the grain contain phenolic chemicals, especially tannins, which act as a physical barrier to prevent fungal infection.

Because the seed coat has a high polyphenol content, the acidic methanol extracted from it showed strong antibacterial and antifungal action when compared to whole wheat extract.

It was observed that there was a negative correlation ($p<0.05$) between the total phenolics and phenolic type (condensed tannins, anthocyanins, and flavan-4-ols) and the fungal load (total fungal load and infection levels) of the unmalted millet grain and its malt. (Mathanghi SK and K. Sudha 2012)

4) Nutritional & Anti-nutritional Property

Even though ragi it has a wide range of nutritional profiles, it also includes anti-nutritional elements such polyphenols, phytate (0.48%), oxalate (0.27%), cyanide (0.17%), tannins (0.04-3.47%), and oxalate (0.27%) therefore ragi has a greater tannin concentration (0.04 to 3.47%) than any other millet.

Finger millet's tannin level varies depending on the variety. Study have shown that a deep brown variety of finger millet has 0.61% tannin, whereas a white variation has 0.05% tannin.

With the use of certain pre-treatments including roasting, soaking, boiling, parboiling, fermentation, milling, germination, decortications, and extrusion cooking, the amount of anti-nutritional elements can be decreased to acceptable levels. (Rathore *et al.*, 2019)

Finger millet is an excellent source of minerals, fiber, and calcium. Finger millet grain has a very high nutritious content. It has 1% to 1.7% fat, 6% to 8% protein, 65% to 75% starch, 2% to 2.25% minerals, and 18% to 20% dietary fiber. Its relative composition is better than that of rice, sorghum, wheat, and maize in terms of dietary fiber, calcium, and a few other micronutrients.

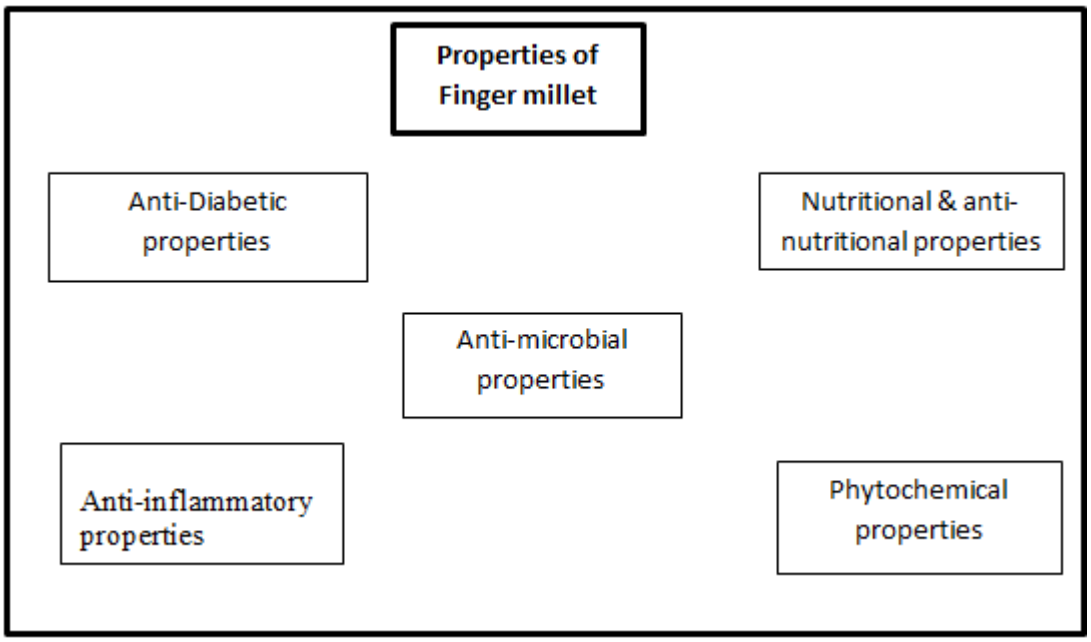
This millet's seed coat provides an abundant source of nutrients, dietary fiber, and phenolic compounds. (Ambre *et al.*, 2020)

5) Phytochemical Property

The study shows that the finger millet's alkaloid concentration (36.03%–68.44%) was lower than pearl millet's (49.50%–74.53%) and the millet flour's alkaloid content rose after germination.

Alkaloids function as sedatives, stimulants, relaxants, and tranquilizers in addition to their other effects. Alkaloids are used in medicine because of their ability to operate rapidly on nervous system regions.

(Owheruo, *et al.*, 2018



C. Processing technologies for Finger Millet

1) Milling

Typically, finger millet is ground into flour to be used in culinary preparation. It is first washed to get rid of any unwanted objects like stones, chaff, stalks, etc., and then it is ground into a fine powder using friction or abrasive mills to separate the glumes (non-edible cellulosic tissue). A stone mill, an iron disk, or an emery coating round mill is used to grind it. Pearling or decortications are occasionally employed to dehusk the millet finger grain; this causes the seed coat and endosperm to be ground up. An additional purpose for a centrifugal sheller is to peel or decorticate the little millet grains.

2) Decortication

This method was created for finger millet recently commonly known as debranning. All cereals can be debranned using this technique, although finger millet cannot be successfully debranned since its delicate endosperm is attached to the seed coat. However, finger millet is decorticated using a method called hydrothermal processing, which entails hydration, steaming, and drying to harden the grain's endosperm and make it resistant to mechanical impact.

3) Malting

Finger millet is frequently malted for use in gourmet cuisine. The bioavailability of minerals, proteins, and carbohydrates is improved during this procedure.

Anti-nutritional components are concentrated less, and some B-group vitamins are produced. Viable seeds are soaked in water during the malting process to help them hydrate and sprout. After that, these sprouts are dried. Lastly, by hand-rubbing, the rootlets are removed from the grain. Each of these processes affects the malt's quality. The most crucial stage in the process is seed germination because it produces the hydrolytic enzymes that alter the endosperm and improve its nutritional value. Finger millet has been successfully malted to produce a range of healthy foods, including baby food, weaning meals, milk-based drinks, and confections.

D. Products made from Finger Millet

1) *Chapatti (roti):* For preparing chapatti (roti), a 7:3 ratio of wheat to finger millet works well. Even though there is less gluten in this suggested combination, it still makes very fine chapattis. Additionally, the chapatti's color becomes a little darker. Incorporating finger millet into chapattis not only enhances their flavor but also effectively regulates blood sugar levels in those with diabetes. We feel fuller after consuming less calories due to the slower digestion rate and bulkiness of the fibers, which may help us avoid overindulging in calories. Additionally, the fiber content of finger millet is beneficial to those who struggle with constipation.

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2) *Papad:* As a basic material, finger millet flour is used to produce papad, which is made with 15-20% (w/w) of the flour and other necessary components such rice, green or black gram, and spices. To make dough, the flour is first boiled in water until it becomes gelatinous. This dough is rolled into thin sheets and cut into the necessary shapes and sizes. Then, the papad pieces are dried until the desired moisture content of 7–8% (db) is reached. However, because the pericarp and starch are not separated, the papad becomes somewhat darker in color. This is something that is well-liked by consumers when the papad is fried or roasted.
3) *Vermicelli/Noodles:* A sizable market for noodles exists both in India and elsewhere due to the shifting eating patterns of children and adolescent populations. Because more people are becoming aware of finger millet's nutritional benefits, there is an increasing demand for millet noodles. Noodles are manufactured in many combinations, all of which are made solely with finger millet, in a 1:1 ratio with wheat, and in a 5:4:1 ratio with finger millet combined with wheat and soy flour. Noodles, commonly referred to as convenience meals, are pasta-like goods made using a cold extrusion process that dries up and becomes brittle and rigid. These noodles boil quickly and easily in a matter of minutes.
4) *Fermented Food:* In several regions of India, idli and dosa are popular fermented dishes. In the southern portion of the nation, they are also highly typical evening meals and breakfast items. Finger millet is a common component for these types of fermented cuisine. This millet not only enhances the flavor but also increases the amount of protein, calcium, and fiber in the diet. Depending on preference and flavor, fermented dishes can also be made with malted grains or sprouted finger millet.

II. CONCLUSION

Finger Millet is considered an elite grain with various nutrients and disease curing benefits. Since this millet is underutilized and majorly grown for cattle fodder, the population is unaware of its benefits. This paper marks the various micro and macronutrients consisting of calcium, protein, tannin, carbohydrate, crude fiber and phytochemicals in a considerable amount. Along with nutrient composition finger millet if added into diet can result in weight management, prevention of diabetes and hypertension. Satisfactory studies who prepared food products or recipes and intervened among consumers, further resulted in decreased prevalence of disorder or diseased condition. It exhibits different types of properties namely anti-inflammatory, anti-diabetic, anti-microbial and phytochemical properties.

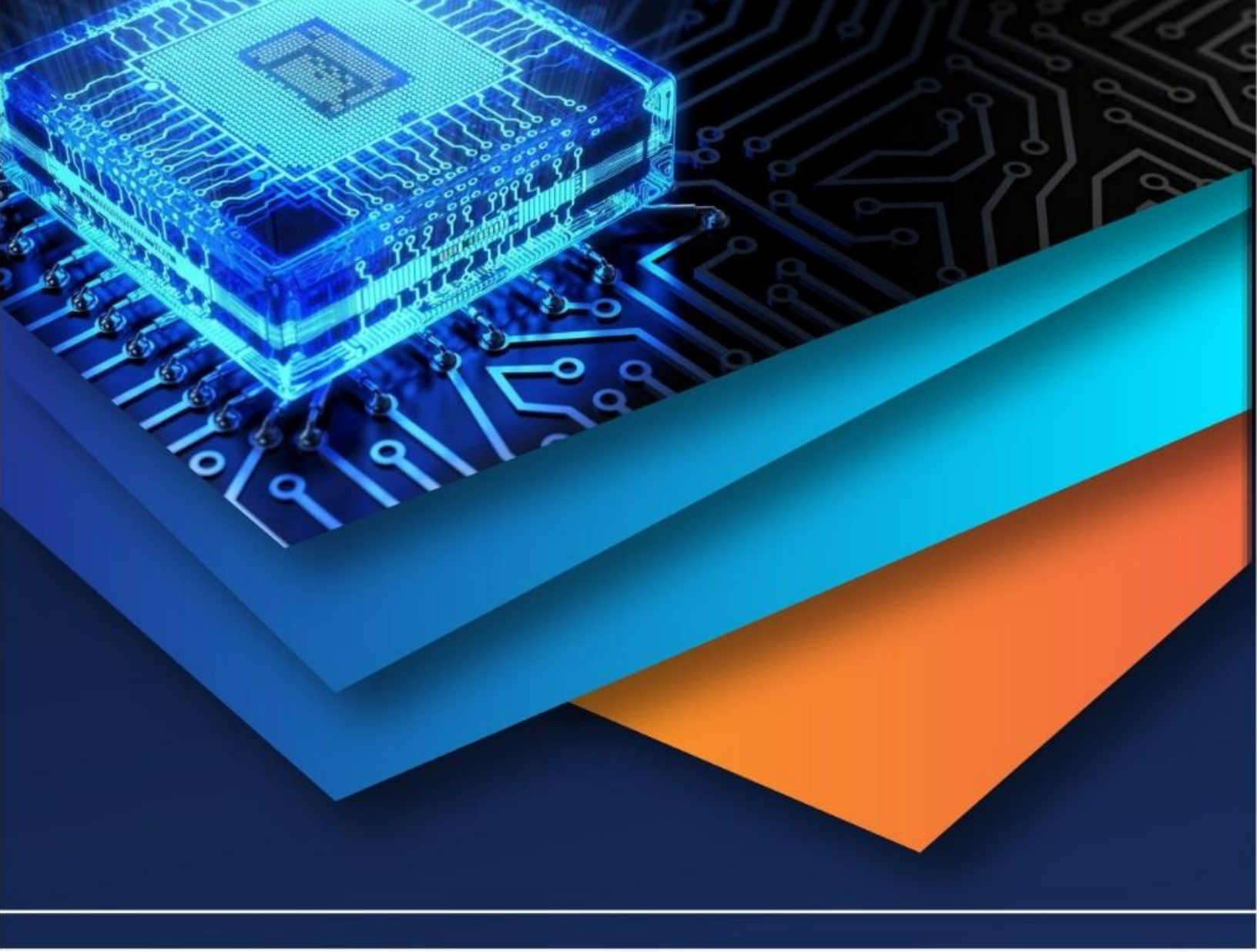
To promote health individual should add ragi in the diet in the form of various food products such as cookies, noodles, pappad etc since ragi is one disease curing superfood.

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