Journal of Advances in Biology & Biotechnology

Volume 27, Issue 7, Page 605-617, 2024; Article no.JABB.118662
ISSN: 2394-1081

Nutritional Advantages and Opportunities for Its Processing of Finger Millet (*Eleusine coracana* L.): A Comprehensive Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jabb/2024/v27i71021

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/118662

Review Article

Received: 14/04/2024
Accepted: 18/06/2024
Published: 19/06/2024

ABSTRACT

Finger millet (*Eleusine coracana* L.) stands out as a highly nutritious yet underutilized grain among the millets. Despite its substantial health benefits, finger millet remains one of the least consumed foods globally. With the world's population growing at an unprecedented rate, addressing food security and malnutrition is a critical challenge. UNICEF reports indicate that nearly 2 billion people suffer from hidden hunger, and one in five children under five years old experience stunted growth

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Cite as: Simran, Sahil Chaudhary, Harshal Avinashe, and Nidhi Dubey. 2024. "Nutritional Advantages and Opportunities for Its Processing of Finger Millet (Eleusine Coracana L.): A Comprehensive Review". Journal of Advances in Biology & Biotechnology 27 (7):605-17. https://doi.org/10.9734/jabb/2024/v27i71021.

due to malnutrition. Finger millet offers a promising solution to these issues due to its rich nutritional profile, which surpasses that of many common cereals. This review comprehensively examines the nutritional advantages of finger millet, highlighting its high content of calcium, iron, dietary fiber, and essential amino acids. Additionally, finger millet is a rich source of antioxidants and has a low glycemic index, making it beneficial for managing diabetes and other metabolic disorders. The review also explores various opportunities for processing finger millet to enhance its appeal and consumption. Processing techniques such as malting, fermentation, and extrusion can improve the bioavailability of nutrients and create diverse, palatable food products. By leveraging modern processing technologies, finger millet can be transformed into a staple food that addresses nutritional deficiencies and contributes to global food security. This review aims to underscore the importance of finger millet in combating malnutrition and promoting sustainable food systems. Increased awareness and research into finger millet's nutritional benefits and processing opportunities can pave the way for its broader adoption and integration into daily diets, ultimately contributing to better health outcomes worldwide.

Keywords: Malnutrition; health benefits; amino acids; processing; value addition.

1. INTRODUCTION

Term millet is derived from French word ‘mille’ which means thousand as a handful of millet contains about 1000 grains [1]. Finger millet also belongs to the millet group .It is known as ragi or mandua in India, bulo and wimbi in Uganda, rapoko in South Africa, sarga ,pawana and tamba in Nigeria and African millet, coracana and birdsfoot are some of its English names [2-4]. It belongs to family *Poaceae* and sub family *Chloridodeae* [5-7]. Various regions of India and Africa plant finger millet (*Eleusine coracana* L.), because it is a wholesome cereal grain with numerous health advantages [8,9-12]. Africa alone produces about 55-60% of finger millet [13]. India produces about 2.5 million tons of finger millet, while the total global production is 4.5-5 million tons [14]. India contributes to about 60%of the total global production [15] which makes India the largest producer of finger millet [16,17]. Apart from India and Africa, it is also cultivated in Taiwan, China, South Carolina in USA [14].

Finger millet contains various vital nutrients like carbohydrates, essential amino acids, minerals and dietary fiber [6,18]. Calcium content in some of the major grains ranges from 0.01-0.06 percent while it is 0.34 percent in finger millet [19,20]. Finger millet can be consumed by people suffering from celiac disease as it is gluten free and easy to digest [21,22]. It also has numerous other health benefits which include anti-ulcerative properties, hypoglycemic and hypocholesterolemic effects [23]. The seed coat of finger millet is rich in various phytochemicals and can be consumed [24,25]. The content of these nutrients can further be increased by processing and value addition of finger millet.

2. NUTRITIONAL CHARACTERISTICS OF FINGERMILLET

Finger millet have nutritional potential that is comparable to common cereals like rice, wheat, barley, or bajra in terms of protein, carbohydrate, and calorie levels. It contains about 65-75%carbohydrates, 5-8% proteins, 15-20% dietary fibers, 2.5-3.5% minerals and 1-2% ether extractives (NCBI). The quantity of Ca present is highest in finger millet 162.0-358.0mg/100g as compared to other millet species [26,27]. Calcium is very crucial for growing children, elderly and also for pregnant women [28,29]. Deficiency of Ca can be cured by consuming finger millet [30]. Apart from Calcium P is also present in significant amount in finger millet i.e., 130.0-283mg/g. Phosphorus helps in development of body tissue and energy metabolism [7,31]. Also significant amount of Magnesium is present in finger millet which helps in decreasing the severity of asthma, risk of heart attack, high blood pressure, frequency of migraines [32-34]. Even though finger millet contain such a high amount of minerals still it’s potential is not completely utilized [27].

As outlined in Table 1, finger millet contains 7.3% protein, 1.3% fat, 59.0% starch, and an impressive 19.1% total fiber. Compared to wheat, which has a higher protein content at 14.4% [35] but lower total fiber at 12.1%, finger millet's high fiber content is particularly beneficial for digestive health and managing blood sugar levels. Although rice contains a similar protein percentage (7.5%) and higher fat content (2.4%), its starch content (77.2%) and significantly lower fiber (3.7%) make it less favorable for sustained energy release and digestive health. Barley, with 11.5% protein and 15.4% fiber, and sorghum,

with 11% protein and 11.8% fiber, also present substantial nutritional benefits, yet they lack the unique combination of high fiber and moderate protein found in finger millet. Maize and pearl millet offer higher fat content (4.6% and 5.1%, respectively) and moderate fiber levels (12.8% and 7.0%, respectively), while kodo millet excels with the highest fiber content at 37.8%, making it another significant option for dietary fiber intake. Foxtail millet, similar to finger millet, balances its nutritional profile with 11.7% protein, 3.9% fat, 59.1% starch, and 19.11% fiber. The diverse nutritional advantages of finger millet, including its high dietary fiber and balanced protein content, underscore its potential to address malnutrition and improve overall health outcomes. By incorporating modern processing techniques, the utilization of finger millet can be enhanced, paving the way for its integration into daily diets and contributing to global food security and nutritional well-being.

As shown in Table 2, finger millet contains significant amounts of phosphorus (0.24%), potassium (0.43%), calcium (0.33%), magnesium (0.11%), sodium (0.02%), iron (46 mg/kg), zinc (15.0 mg/kg), and manganese (7.5 mg/kg). This comprehensive mineral profile highlights its potential to contribute to various physiological functions and prevent mineral deficiency-related ailments. Comparatively, wheat exhibits higher phosphorus (0.35%) and magnesium (0.14%) levels, along with substantial iron (40.1 mg/kg) and zinc (30.9 mg/kg) content [36,37], although its calcium content (0.04%) is significantly lower than that of finger millet. Rice, while widely consumed, falls short in mineral richness with notably lower percentages across all minerals, particularly calcium (0.02%), iron (19.0 mg/kg), and zinc (10.0 mg/kg). Barley matches finger millet in potassium content (0.50%) and exceeds in phosphorus (0.56%) and magnesium (0.14%), but lags in calcium (0.04%) and iron (36.7 mg/kg). Sorghum stands out with the highest iron content (50.0 mg/kg) among the listed crops but offers lower calcium (0.04%) and moderate levels of other minerals. Maize provides balanced mineral content but with lower calcium (0.03%) and manganese (5.0 mg/kg) compared to finger millet [38]. Pearl millet surpasses all in iron content (74.9 mg/kg) and also has significant zinc (29.5 mg/kg) and potassium (0.44%) levels, although its calcium (0.01%) and magnesium (0.13%) contents are low. Kodo millet and foxtail millet present moderate mineral profiles with kodo millet having lower iron (7.0 mg/kg) and foxtail millet showing balanced levels of essential minerals. This extensive mineral composition reinforces finger millet's role in fortifying diets, particularly in regions prone to micronutrient deficiencies. Its high calcium and iron content make it an excellent option for addressing osteoporosis and anemia, respectively. By leveraging modern processing techniques, finger millet can be transformed into various value-added products, enhancing its market appeal and nutritional impact.

Vitamins are micronutrients that are required for normal growth and maintainance of body. These are grouped into two categories -water soluble vitamins and fat soluble vitamins. Finger millet contains both of these kind of vitamins especially Vitamin A &B complex [8,28]. But Vitamin C is not present in the dried grain [39]. Table 3 illustrates the vitamin composition of various cereals and millets, providing a comparative view that highlights the unique nutritional advantages of finger millet. Finger millet contains 0.12 mg of riboflavin, 0.48 mg of thiamine, and 0.30 mg of nicotinic acid per 100 grams. While its riboflavin and thiamine content are comparable to other cereals, its nicotinic acid content is modest. In comparison, wheat and barley are significantly higher in nicotinic acid, with 7.40 mg and 7.20 mg per 100 grams respectively. This makes them excellent sources for combating niacin deficiency but also highlights an area where finger millet can be improved through biofortification or complementary dietary planning. Rice, a staple food for a significant portion of the global population, has relatively low vitamin content with only 0.03 mg of riboflavin, 0.07 mg of thiamine, and 1.60 mg of nicotinic acid per 100 grams, emphasizing the need for diversifying diets to include more nutrient-rich cereals like finger millet. Sorghum and maize offer balanced vitamin profiles, but finger millet’s comparable levels of riboflavin and thiamine make it a valuable addition to a diversified diet. Pearl millet, with the highest riboflavin content at 0.22 mg per 100 grams, also presents a strong case for inclusion in diets aimed at improving vitamin intake. Meanwhile, foxtail millet, similar to finger millet, shows balanced levels of riboflavin (0.12 mg), thiamine (0.48 mg), and a higher nicotinic acid content (3.70 mg). The vitamin composition of finger millet reinforces its role as a nutritious food crop. By integrating finger millet into regular diets, populations can benefit from its nutritional strengths, particularly in areas where deficiencies in essential vitamins are prevalent. Additionally,

further research and processing innovations can help enhance the vitamin content and bioavailability in finger millet, unlocking its full potential as a staple food.

Table 4 and Table 5 provide detailed insights into the amino acid composition of finger millet, highlighting its potential as a source of high-quality protein.

Table 1. Nutritional composition of cereals and millets [8]

Crop	Protein (%)	Fat (%)	Starch (%)	Total fiber (%)
Finger millet	7.3	1.3	59.0	19.1
Wheat	14.4	2.3	64.0	12.1
Rice	7.5	2.4	77.2	3.7
Barley	11.5	2.2	58.5	15.4
Sorghum	11	3.2	73.8	11.8
Maize	12.1	4.6	62.3	12.8
Pearl millet	14.5	5.1	60.5	7.0
Kodo millet	8.3	1.4	72.0	37.8
Foxtail millet	11.7	3.9	59.1	19.11

Table 2. Mineral composition of cereals and millets [8]

Crop	P (%)	K (%)	Ca (%)	Mg (%)	Na (%)	Fe (%)	Zn (%)	Mn (%)
Finger millet	0.24	0.43	0.33	0.11	0.02	46	15.0	7.5
Wheat	0.35	0.36	0.04	0.14	0.04	40.1	30.9	40.0
Rice	0.12	0.10	0.02	0.03	0.00	19.0	10.0	12.0
Barley	0.56	0.50	0.04	0.14	0.02	36.7	23.6	18.9
Sorghum	0.35	0.38	0.04	0.19	0.05	50.0	15.4	16.3
Maize	0.29	0.37	0.03	0.14	0.03	30.0	20.0	5.0
Pearl millet	0.35	0.44	0.01	0.13	0.01	74.9	29.5	18.0
Kodo millet	0.32	0.17	0.01	0.13	0.01	7.0	-	-
Foxtail millet	0.31	0.27	0.01	0.12	0.01	32.6	21.9	21.9

Table 3. Vitamin composition of cereals and millets

Crop	Riboflavin (mg/100gm)	Thioamine (mg/100gm)	Nicotinic acid (mg/100gm)
Finger millet	0.12	0.48	0.30
Wheat	0.12	0.57	7.40
Rice	0.03	0.07	1.60
Barley	0.15	0.44	7.20
Sorghum	0.15	0.46	4.84
Maize	0.14	0.38	2.80
Pearl millet	0.22	0.38	2.70
Kodo millet	0.05	0.32	0.70
Foxtail millet	0.12	0.48	3.70

Table 4. Various essential amino acids in finger millet [40]

Amino acid	g/100g protein	Reference
Valine	4.9-6.6	[41,42]
Leucine	6.6-9.5	[42,43]
Isoleucine	4.3	[8,44]
Threonine	3.4-4.2	[42,43]
Tryptophan	1.1-1.5	[42,43]
Histidine	2.2	[42]
Lysine	2.2	[8,44]
Phenylalanine	4.1-5.2	[42,43].
Methionine	2.5-3.1	[42,43]

Table 5. Various non-essential amino acids present in finger millet [40]

Non-Essential Amino Acids	g/100g protein	Reference
Glutamic Acid	20.3-27.1	[41,42]
Asparatic Acid	6.5-7.9	[41,42]
Arginine	2.77-4.5	[41,42]
Alanine	6.1-6.2	[41,42]
Proline	7.0-9.9	[41,42]
Tyrosine	2.79-3.6	[41,42]
Glycine	2.14-4.0	[41,42]
Serine	3.6-5.1	[41,42]
Cystine	1.7-2.6	[41,42]

2.1 Essential Amino Acids

Finger millet is rich in essential amino acids, which are crucial for various bodily functions and must be obtained through the diet. The amino acids found in finger millet include valine (4.9-6.6 g/100g protein), leucine (6.6-9.5 g/100g protein), isoleucine (4.3 g/100g protein), threonine (3.4-4.2 g/100g protein), tryptophan (1.1-1.5 g/100g protein), histidine (2.2 g/100g protein), lysine (2.2 g/100g protein), phenylalanine (4.1-5.2 g/100g protein), and methionine (2.5-3.1 g/100g protein). These essential amino acids play critical roles in protein synthesis, tissue repair, and nutrient absorption.

2.2 Non-Essential Amino Acids

Finger millet also contains significant amounts of non-essential amino acids, which, although synthesized by the body, are essential for supporting metabolic processes and overall health. The non-essential amino acids present in finger millet include glutamic acid (20.3-27.1 g/100g protein), aspartic acid (6.5-7.9 g/100g protein), arginine (2.77-4.5 g/100g protein), alanine (6.1-6.2 g/100g protein), proline (7.0-9.9 g/100g protein), tyrosine (2.79-3.6 g/100g protein), glycine (2.14-4.0 g/100g protein), serine (3.6-5.1 g/100g protein), and cystine (1.7-2.6 g/100g protein).

2.3 Polyphenols and Dietary Fibre

Compared to many other cereals including barley, rice, maize, and wheat, finger millet grain has a dark brown seed coat that is rich in polyphenols. The phenolics in this grain are not evenly distributed; instead, they are primarily concentrated in the outer layers of the grain, specifically the testa, pericarp, and aleurone layer, which make up the majority of the bran portion. There are two kinds of phenolic chemicals found in grains: free, soluble conjugates and insoluble bound forms. The two main bound phenolics found in finger millets are p-coumaric acid and ferulic acid, of which the bound phenolic fraction makes up 64–96 and 50–99% of the total phenolic content of millet grains, respectively.

Finger millet, which has a high dietary fibre and polyphenol content, is known to have a protective effect against gastrointestinal tract illnesses and diabetes mellitus when consumed regularly. Comparing finger millet to many other grains, it has a higher proportion of nutritional fibre.

The delayed absorption of nutrients, increased volume in the faeces, decreased blood cholesterol, protection against colon cancer, digestive barrier, intestinal contents mobility, longer poo transit time, and fermentability properties are all linked to the health advantages of finger millet [15].

3. HEALTHY COMPOUNDS PRESENT IN FINGER MILLET

Finger millet has various compounds present which have numerous health benefits tabulated in Table 6 and Fig. 1.

4. PROCESSING OF FINGER MILLET

Finger millet grains are processed through various means to convert them to suitable form in which they can be consumed. Soaking, fermentation, milling, germination and malting are some of the traditional forms of processing of finger millets [45]. These traditional ways of processing are mostly practiced in developing countries of Asia and Africa [33]. In urban areas, finger millet is mostly consumed after its value addition. There are numerous value added products that can be obtained by processing and conversion of finger millet like composite flour or multigrain flour, vermicelli, bakery products, fermented foods, papad, soups, ready to eat meals, extruded products etc [46].

Table 6. Healthy compounds present in finger millet: Finger millet has various compounds present which have numerous health benefits

Healthy compounds	Benefits	Reference
Dietery fibre	Essential for the hypoglycemic, hypolipidemic, and serum cholesterol-lowering effects. It halts atherosclerosis and has anti-toxin and anti-cancerous properties.	[47,48].
Phytic acid	It helps to decrease the cholesterol level in the body.	[49,50,51]
Ferulic acid	It promotes the wound healing process and also ceases the damaging of tissues.	[51]
Nutraceutical foods	It reduces the risk of chronic diseases like obesity, which improves health and also reduces diabetes, cancer, and blood pressure.	[51]
Tannis ,phylates and phenols	These are crucial for metabolic syndrome, ageing, and repair. These also prevents cancer and cardiovascular diseases from spreading among people. It also lowers diabetes and blood pressure. These also reduces the risk of tumor in human body.	[47,52]
Phosphorus	It helps in metabolism of energy in body and is also very crucial for the development of body tissues.	[50]
Magnesium	It lowers the chances of heart attack	[50]

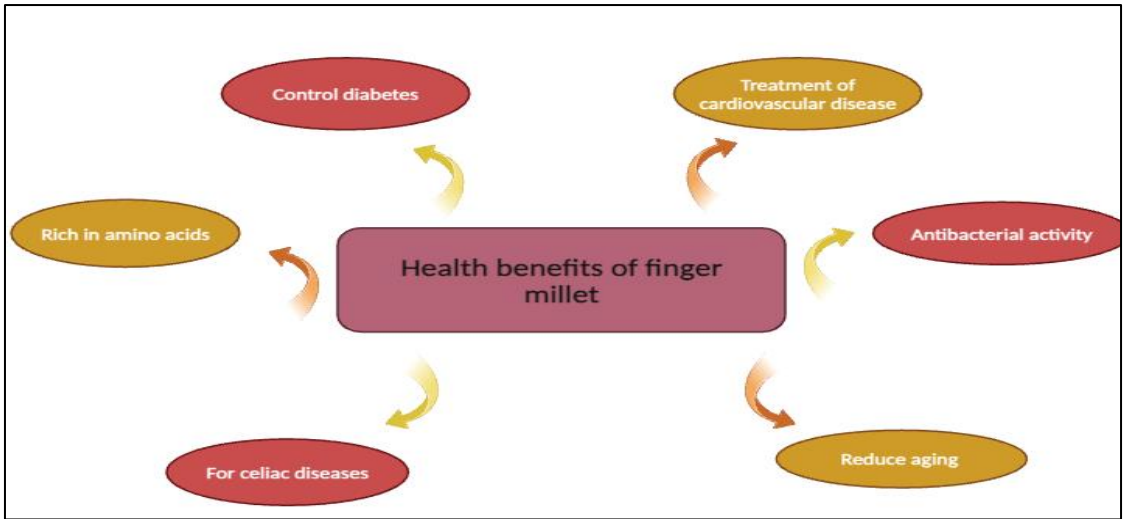

Fig. 1. Potential health benefits of finger millet

4.1 Common Processing Methods of Finger Millet

Soaking: This technique is practiced as it leads to the reduction of antinutritional compounds like phytic acid and also leads to improvement in bioavailability of minerals like iron and zinc [33]. In this process, finger millets are added to distilled water and left overnight at an temperature of 30-60 degree Celsius Finger millet grains are then taken out from water. These are further cleaned using fresh water to remove any contaminants present. Then these are oven dried at 60 degree Celsius for about 90 min before milling.

Milling: It is basically removal of bran which includes pericarp, seed coat, aleurone layer and nucellar epidermis. Since seed coat of finger millet is tightly attached to friable and also it contains soft endosperm so abrasive milling machinery cannot be used for milling of finger millet [45]. So it can be done by addition of 3-5% moisture followed by tempering for half an hour to soften the bran and to reduce the friability and then followed by sieving after crushing leads to removal of most of the bran.

Malting: Malting involves the amalgamation of a no. of processes like Steeping, germination, kilning, milling, and sieving to increase the

nutritional quality of the product, which further leads to improvement in starch digestibility, and sensory attributes [53]. It is observed that finger millet malt has a very pleasant flavor when starch-hydrolyzing enzymes are present in sufficient amounts. After 4 to 5 days of germination, amylase activity reaches its peak. It makes an excellent base for weaning food formulations since it is high in calcium and Sulphur amino acids. The millet malt is used to create beverages by mixing milk and lukewarm water with sugar and to make baby food [45]. Also malting of finger millet grains lowers the effect of antinutrients and also increases its nutritional qualities [54].

Fermentation: In these process grains of finger millet act as medium of growth for various microorganisms. It takes about 24-72hours for the fermentation of finger millet grains. This process is utilized in traditional as well as in commercial industries for the production of various value added products. This technique enhances the amino acid balance, sensory quality, nutritional value, and resistance to spoilage and pathogenic bacteria of the grains [55]. It also decreases the content of antinutritional compounds like tannins, amylase inhibitor, tryptin and phytic acid in cereals [55].

Roasting:-This method has been practiced in rural areas from a long time. A more straightforward and widely used household and village level technology is roasting cereals, pulses, and oilseeds. It is said to eliminate the majority of antinutritional or toxic effects, including hemagglutinin, trypsin inhibitors, gioterogenic agents, cyanogenic glycosides, alkaloids, and saponins, and to extend storage life [56].

Cooking:-This process involves boiling the grains of finger millet so that they become soft, then they are mashed and are added in water once again to make a soup [40]. Finger millet grain can also be cooked by mixing flour and boiling water to produce porridge [57].

Puffing or Popping:-This method is used for making ready to eat products and also to increase shelf life of such products that are porous and crunchy [58,56]. It involves soaking the unhusked grain in water and then mixing it with hot sand(250 °C) for 15-60 sec [44,59].

Currently mass production of puffed millet grains can be done by using modern air puffed machines. Puffing has several benefits which includes enhancement of the overall dietary fibre and reduction of antinutritional factors [59,60].

5. DIFFERENT VALUE ADDED PRODUCTS OBTAINED FROM FINGER MILLET

Noodles/Vermicelli: Since noodles is a very popularized dish among children as well as adults, its demand has significantly increased in recent years throughout the world. Ragi can also be used in formation of noodles and it will serve a healthy alternative due to its nutritional value. Noodles can be prepared by using different ratios of ragi and wheat like (1:1), ragi wheat and soy flour (5:4:1). Convenience meals, or noodles, are pasta-like goods made by a cold extrusion process that dry up and become brittle and hard. These noodles cook quickly and easily in only a few minutes [16].

Multigrain flour: Multigrain flour or composite flour has been consumed by human kind since the past ages so it is not a new concept for humankind. Mixing of different flours increases the nutritional content of the food by inculcating the nutritional properties of various flours. It is a healthy alternative to the all purpose flour .In this case wheat and ragi are mixed in the ratio 7:3. It can then be consumed in the form of chapatis. It significantly improves the nutritional content of chapati and also increases its taste. It also reduces the gluten content of chapati. It has various benefits like it lowers the glucose levels so it can be consumed by diabetic patients , it also increases the fibre content which is helpful in decreasing the speed of digestion which is helpful for people suffering from constipation issues. It also reduces the caloric intake thereby helping to decrease obesity, which is an increasing problem and a major health issue in the whole world [39].

Papad: In South Indian regions that cultivate millet, it is customary to add finger millet as one of the primary ingredients, to the extent of 15-20% (w/w), along with other necessary ingredients like rice, black or green gramme, and spices. A report states that it is feasible and common in some areas of Karnataka to add finger millet up to 60% of the papad**.** Papad can be prepared from finger millet by mixing salt and spices. Firstly dough is prepared by mixing finger millet, water .Then thin sheets are prepared from the dough by rolling it, and then it is cut and allowed to dry until the moisture content is

significantly reduced to 7-8%. Colour of the papad is a bit dark as compared to regular papad due to the presence of pericarp along with starch . But it turns lighter while roasting or frying [39].

Ragi soup: It is prepared by mixing water and ragi (2.5:1). To avoid the lump formation it should be stirred continuously. Prepare a generous mix and heat it for about 15 minutes on medium heat flame. Let it cook completely. There should be no lump formation. To avoid it, there should be continuous stirring. After cooking it should remove from the flame. Let it cool for about 5 minutes and then mix curd and salt in it. It is ready to be served. Apart from this Ragi vada and ragi pakoda can also be prepared from this millet. According to the local taste and preferences there are several other items prepared from ragi like foodles, multigrain noodles, ragi biscuits, vermicelli etc. It can also be consumed in form of a healthy drink called ragi baby vita which has numerous health benefits [16].

Ragi pakora/fritters: Chop onion in longitudinal directions. Using a knife, crush the garlic. Set them apart. In a bowl, combine ragi flour, red chilli powder, cumin seeds, crushed garlic, and salt. To prepare a more liquid-like mixture, add 1/2 to 3/4 cup of water to the ingredients. After chopping the onion, add it to the flour mixture and thoroughly coat it. Warm up some oil in a pan. When the oil is sufficiently hot, add the onion covered in flour and fried it until it crisps. Warm up and serve [39].

Bakery products: There have been attempts to prepare bakery goods such bread, nankhatai, cookies, and muffins using finger millet flour, and efforts have begun to standardise the recipe and product quality. Not only would using millet improve the products' fibre and micronutrient content, but it will also open up new opportunities for millet to be used in bakery goods with various value-added products. Malted finger millet flour has been added in an effort to enhance the nutritional content of cakes in terms of their fibre and mineral content, according to a recent study. Recent years have seen a rise in interest in finger millet, and initiatives are being made to make it available to consumers in convenient formats [61].

Ragi vada: Begin with cutting the greens (Keerai) and onions. Set them apart. All the components, excluding the oil, should be combined in a vessel. Made into a soft dough that is somewhat thinner than chapati dough, add the necessary amount of water. In a pan, heat up some oil. With the use of your fingers, compact a tiny bit of dough, then drop it into the heated oil. Fry until crispy or until virtually no more bubbles form [39].

Millet flakes: The advantageous characteristic of millets, which cook softly in 5 to 10 minutes when submerged in boiling water, should be used to create quick-cooking cereals. In order to prepare the flakes, pearled grains are cooked under high pressure until the starch is entirely gelatinized. Once the grain has dried to an 18% moisture content, it is crushed between heavy-duty rollers. Millets work well for making flakes because of their small size. Flakes immediately hydrate when mixed with milk or water [45].

Fermented foods: Many regions of India are fond of fermented meals like dosa and idli. In the southern portion of the country, these are highly popular for breakfast and even dinner. These sorts of fermented dishes frequently include finger millet as one of their ingredients. It enhances the food value in terms of protein, calcium, and fibre while also making the food taste better. Depending on the preference and flavour, malted grains or finger millet sprouting can also be utilised for fermented cuisine. The other basic components for fermented dishes are combined with ragi flour once additional steps are taken [34].

6. ADVANTAGES OF FINGER MILLET

a. **For treatment of cardiovascular diseases:** Finger millets include three amino acids: methionine, threonine, and lecithin. These three amino acids help to reduce cholesterol, eliminate extra fat from the liver, and impede the development of new fat. Additionally, the concentration of serum triglycerides in finger millet is low. Finger millet eating lowers plasma triglyceride levels, which reduces the risk of cardiovascular disease [62]. Therefore, people suffering from various cardiovascular diseases can consume it.

b. **Effective cure for diabetes:** Consumption of finger millet helps to control the blood sugar level by slowing down the process of digestion. Additionally it also has antioxidants properties which are further helpful in this process [63]. By limiting the function of enzymes necessary for the

digestion of complex carbohydrates, such as amylase and alpha-glucosidase, the phenolic seed coat of finger millet serves as an inhibitor to assist lower postprandial hyperglycaemia. In comparison to wheat and rice, finger millet has a higher fibre content. Its low glycemia response also means that it has less capacity to raise blood sugar and improve starch absorption [64].

c. **Rich in amino acids:** The body's ability to function and heal its tissues depends heavily on amino acids. Finger millets are abundant in methionine, threonine, valine, isoleucine, and tryptophan.

- Essential amino acid methionine is necessary for the body to produce glutathione, a natural antioxidant, and plays a major part in the removal of excess fat. It also provides sulphur to the body, which is needed for various bodily functions.

- Isoleucine aids in the healing of damaged muscle tissue and blood production, both of which support the development of bones. It also aids in the restoration of healthy skin.

- Amino acids also serve to regulate the body's nitrogen content, enhance metabolism, and sustain muscle and tissue repair coordination [64].

d. **For celiac disease:** In people who are genetically susceptible, the absorption of gluten results in the immunity-based illness known as celiac disease. Due to its gluten-free nature, finger millet is a good choice for people with celiac disease, those who are sensitive to gluten, and those who just detest the gluten found in wheat and other common cereal grains [33,65].

e. **For reducing the effects of aging:** Antioxidants and phenolics, which are important markers for ageing, metabolic syndrome, and overall health, are abundant in finger millets. Finger millet inhibits glycation and collagen cross-linking, two processes that cause ageing in people [57].

f. **Antibacterial activity:** Presence of flavonoids and phenolic in finger millet helps to prevent microbial enzymes and membranes from oxidising, which slows down the growth of bacteria including *E. Coli, B. cereus, Listeria monocytogenes, Staphylococcus aureus, Streptococcus pyogenes, Serratiamarcescens, Proteus mirabilis, Pseudomonas aeruginosa, Klebsiella pneumonia*, and *Yersinia enterocolitica* [66,67].

7. CONCLUSION

Finger millet holds a lot of untapped potential, which needs to be utilized for gaining food security for our future generations. Developing countries such as African and Asian countries need to focus more on finger millet for fulfilling their requirements. There should be increased focus on value addition, processing and fortification of finger millet grains to combat hunger and malnutrition. Finger millet already contains a lot of nutrients as compared to cereals but its further fortification will be even more beneficial. There is also need to amplify research work in development to new and better performing varieties of finger millet. Finger millet can also serve as an gluten free alternative for wheat. It is also helpful for people suffering with obesity and celiac disease. Since it has numerous beneficial properties which are underutilized. Scientists, government institutions, non-government organizations, research institutions and industries need to come together to further increase the research and commercialization of finger millet.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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