A Review on Nutritional Properties and Health Benefits of Finger Millet

ABSTRACT

Finger millet (*Eleusine coracana*) is one of the important small millets with high nutraceutical value in the world. Wide adoptability of finger millet in different types of soil, climate, at. It also grows well in hot climates with short rainfall periods and cool climates with warm millets. A multitude of small farmers grow finger millet with limited water resources and in many countries this crop is often referred to as "poor people's crop". The grains of finger millets are very small in size with brown, light brown and white in colours based on different cultivars. The white cultivars have been developed mainly for the baking industry, the brown and light brown types used for porridge while the brown cultivar is utilized for brewing traditional opaque beer in Southern Africa. Finger millet is considered as a rich sources of calcium and iron in other cereals. Finger millet contains high concentration of carbohydrates, dietary fibre, phytochemicals and essential amino acids; presence of essential minerals; as well as a gluten-free status. Diet is a major focus of public health strategies aimed at maintaining optimum health throughout life, thus preventing early onset of chronic diseases as well as promoting healthier ageing. Many researchers have described that finger millet helps in natural weight loss, strengthens bone, prevents diabetes, prevents anti-ageing , maintains blood pressure levels, protects from disease, improves in hemoglobin status in children etc.,. Studies on the different properties of foods have shown that consumption of certain foods may provide greater health benefits. Finger millet is not only used for human consumption, but it is also used as feed for cattle and birds. Finger millet is used in the preparation of different foods both in natural and malted forms, like porridge, puddings, pancakes, biscuits, roti, bread, noodles, and other snacks. Besides this, it is also used as a nourishing food for infants when malted and is regarded as wholesome food for diabetic patients. Therefore, necessary need to needs to increase production and productivity through various improved technologies to meet our requirements in future and also strengthen public distribution system for achieving nutritional security.

Key Words: Finger millet, nutrients, minerals, health benefits

INTRODUCTION

“Finger millet (Eleusine coracana (L.) is one of the important small millet grown in India. It is a staple food in Southern India and the country's hilly areas and commonly called ragi. The grains of finger millets are very small in size with brown, light brown and white in colours based on different cultivars”. [1] “The white cultivars have been developed mainly for the baking industry, the brown and light brown types used for porridge while the brown cultivar is utilized for brewing traditional opaque beer in Southern Africa” [2]. It is also a good source of calcium (0.344%) and free of gluten. Generally, it is used to make cakes, puddings, and porridge etc. Straw is used for both draught and milch animals. It has a lot of nutritional value and is beneficial, particularly for people suffering from diabetes, liver illness, high blood pressure, cardiac blood pressure, heart weakness, and asthma.

“Finger millet can be successfully grown in the tropics and subtropics, at sea level to an altitude of 2,300 m on hill slopes and plains. It needs less water and is cultivated in places where rainfall can reach 100 cm. In some locations with better rainfall and irrigation, seedlings are transplanted like rice. In south India, it is also grown during both *summer* and *rabi* season, and in north India it is mostly during the *kharif* season. The temperature range of 26-30°C is ideal for optimum development and yield of finger millet. If the temperatures below and above 20°C limit the yield of crops. The crop is drought tolerant yet extremely vulnerable to frost. Finger millet is a semi-arid region crop cultivated in dry areas with limited rainfall and can adapt to various agro-climatic conditions” [3].

Status of Finger millet in world

“Finger millet grows in more than 25 countries in Africa and Asia. Finger millet is native to the Ethiopian region of Africa. The world's top finger millet producers are Uganda, India, Nepal, and China. Finger millet is a widespread millet in many parts of India. It has historically been a significant millet staple meal in portions of eastern and central Africa and is also frequently known as Koracan in Sri Lanka and by other names in Africa” [2]. “In East-Africa and South-East-Asia this minor cereal is a staple food for a large segment of low income group populations” [4]. “India is the major producer of finger millet, contributing nearly 60% of the global production” [5]. “Finger millet is placed in fourth place behind sorghum, pearl millet, and foxtail millet on a scale of cereal production in Africa and Asia” [6]. “Its annual production is at

4.5 million tons where 2.5 million and 1.2 million tons are produced in Africa and India, respectively" [7]. "Additionally, the grains are grown in Nepal, Sri Lanka, and India's Himalayan regions" [8]).

"In India, finger millet is being cultivated in an area of 1.01 million hectares with a total production of 1.67 million tonnes and a yield of 1747 kg/ha. It is widely cultivated in India's hilly areas of Uttar Pradesh and Himachal Pradesh, as well as Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Bihar, Gujarat, and Maharashtra. It is better adapted in higher rainfall areas (600-1,200 mm) particularly to acid soils and matures within 100-130 days. One of the important features of this millet is its ability to adjust itself in different agro-climatic conditions, which reflects it having the highest productivity among millets" [9,10] .

Adoptability of finger millet

"Finger millet (Eleusine coracana G.) is an important food grain crop of the semi-arid tropics, particularly of India and East Africa" [11]. "Finger millet is grown all over the country owing to its wide adaptable capacity. Extremely tolerance to prolonged periods of drought and moisture scarcity increases their importance in food security. It belongs to the orphan crop group, widely cultivated in the past for its high energy value, and is currently cultivated in limited geographical regions. Millets are water-saving, drought-tolerant crops. Attributed to its C4 nature, they are resilient" [12] .

"It is considered as the storehouse of nutritional properties and a potential solution for malnutrition and hidden hunger as it has high nutritive value and is superior to other cereals. India is the major producer of finger millet, contributing nearly 60% of global production. Finger millet continues to grow widely in tropical and sub-tropical areas and also under severe drought and osmotic stress conditions" [3]. "In most African and Asian regions, the height of a finger millet plant ranges between 30 and 150 m" [13]. "Finger millet grain is mostly grown in areas with little or moderate rainfall and can easily adapt to different agro-climatic conditions" [14].

Finger millets in daily food

“The use of finger millet as a dietary supplement is increasing in parallel with research on its multitudinous effects on human health. It is one of the oldest foods known to humans and possibly the first cereal grain used for domestic purposes. In India, millets have been used as a staple food for thousands of years. Today, millet ranks as the sixth most important grain in the world, sustains 1/3 of the world’s population and is a significant part of the diet in northern China, Japan, Manchuria and various areas of the former Soviet Union, Africa, India, and Egypt” [15,16] . It is often considered to be a "poor men's cereal" as it does not require fertilizer input. “Indeed, it is one of the few special species that currently support the world's food supplies and has become a more mainstream supplement to the diet nowadays. It is highly nutritious and considered to be one of the least allergenic and most digestible grains. Finger millet grain possesses excellent storage properties and is said to improve in quality with storage. However, a number of studies showed that they are highly valued as a reserve food in times of famine and can be stored without damage up to 50 years” [17]. “Finger millet is used in the preparation of different foods both in natural and malted forms, like porridge, puddings, pancakes, biscuits, roti, bread, noodles, and other snacks. Besides this, it is also used as a nourishing food for infants when malted and is regarded as wholesome food for diabetic patients” [3]. “Both traditional and modern methods are used in processing of grains. The traditional method of the processing can be employed in the manufacture of value-added products such as soaked, cooked, malted, *papad*, fermented, popped or puffed, extruded and multi-grain flour” [2].

Millet consumption in India

“According to research, consuming whole grains and cereal fibre is inversely related to BMI, waist circumference, total cholesterol, metabolic syndrome, cardiovascular disease mortality, insulin resistance, and type 2 diabetes incidences” [4]. “Consumption of millets, in general, was higher in Gujarat (maize and pearl millet), Maharashtra (sorghum) and Karnataka (finger millet) but almost nonexistent in Kerala, West Bengal, Orissa, and Tamil Nadu, where rice is the main staple food (National Nutrition Monitoring Bureau, NNMB, 2006). Gujarat and Maharashtra used more millets per capita than Karnataka, Madhya Pradesh, and Andhra Pradesh (75, 32 and 16 g/CU/day, respectively; the consumption unit is a coefficient). Orissa (1 g/CU/day) and Tamil Nadu (3 g/CU/day) reported low levels of consumption” [4]. Consumption of finger millet

increases every year (Fig. 1), as all are aware of the importance of finger millets in maintaining good health and a long life.

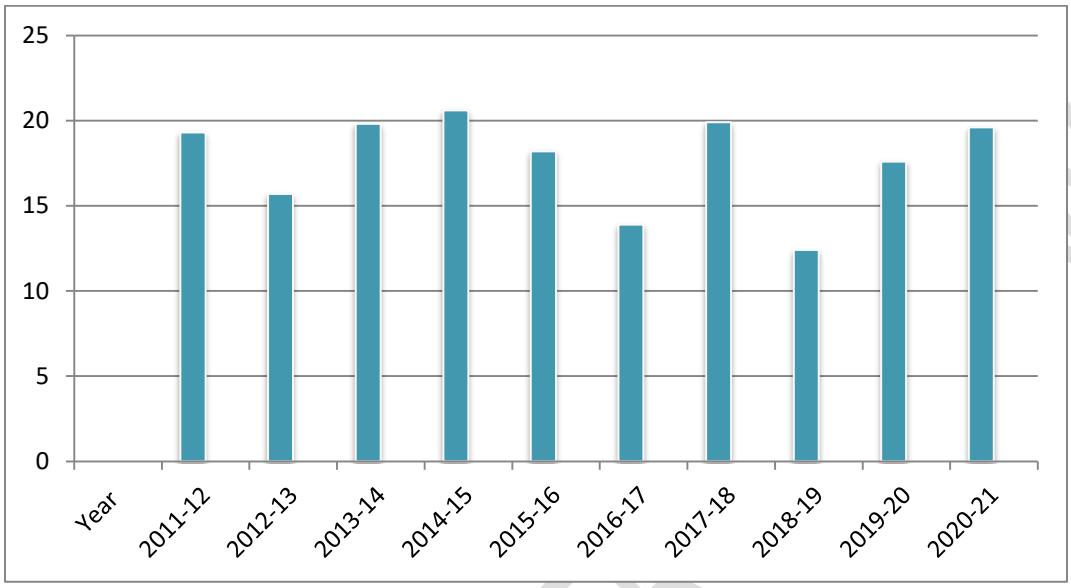

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Fig. 1. Millet consumption (g/day) in India

Nutritional composition of finger millet

"Finger millet is rich in nutrients and offers several health benefits. It consist of essential nutrients like carbohydrates, dietary fibre, essential amino acids, and minerals are present in sufficient amounts in finger millet". [7], "the grains are a good option for those with celiac disease because they are free of gluten and are simple to digest" [18]. "The seeds contain is 0.34 per cent of calcium, compared to 0.01 to 0.06 per cent for other major grains" [6]. "The hypoglycemic and hypo-cholesterolemic effects of the grains as well as their established anti-ulcerative properties are among their health advantages" [19]. "The presence of polyphenols and tannins in the cereal has been linked to some of these health benefits" [20]. "The seed coat contributes to the antioxidant activity" [21]. "The flour used to produce cakes, bread, infants' foods and other pastry products" [22, 23].

"Its crude fiber and mineral content is remarkably higher than those of wheat (1.2% fiber, 1.5% minerals) and rice (0.2% fiber, 0.6% minerals); its protein profile is relatively well balanced; as it

contains more lysine, threonine, and valine than other millets" [24]. "In addition to this, black finger millet contains 8.71 mg/g dry weight fatty acid and 8.47 g/g dry weight protein. Finger millet varieties contain calcium (220–450) and iron (3–20%) respectively. The finger millet contains important amino acids viz., isoleucine (4.4 g), leucine (9.5 g), methionine (3.1 g) and phenyl alanine (5.2 g) which are deficient in other starchy meals. Millets also contain B vitamins, especially niacin, B6 and folic acid, calcium, iron, potassium, magnesium and zinc" [22] .

"Though Indians continue to consume cereals as the main staple providing 70–80% of total energy intake in the majority of Indian diets" [25]. The consumption of millets is very low compared to rice and as evident by our recent study on dietary profile of urban Indians (from the Chennai Urban Rural Epidemiology Study (CURES)) which revealed that, the millets contributed to only about 2% of total calories (6.7 g/d) [19] while almost half of the daily calories were derived from refined grains such as polished white rice (253.4 g/day) [26] .

Finger millet contains carbhohydrate-72-79.5%, protein-7%, ash-1.7-4.13%, Ca-162-487mg%, Fe-3.61 mg/100 mg-5.42mg% [24], carbohydrates -72.6gm, protein-7.7gm, fat-1.5gm, crude fiber-3.6gm, ash-2.7gm, calcium-344mg, phosphorous-250gm, iron-6.3gm [3], carbohydrate-72.6 gm, protein-7.7gm, crude fibre-3.6gm, mineral-2.7%, fats-1.5gm, ash-2.6gm, energy(Kcal)-336, Ca-350mg, Fe-3.9mg, thiamin-0.42mg, Niacin- 0.19mg, riboflavin-1.1mg [12], protein-9.2%, fat-1.29%, carbohydrates-76.32%, minerals -2.2%, ash-3.9%, calcium-0.33%[11]. Finger millet contains protein 6.12 %, fat 1.06%, ash 2.13%, carbohydrate 79.52%, starch 69.26 % and total sugar 1.33% [27]. "The raw **finger millet** flour had good amounts of crude protein (4.6%), crude fat (3.06%) and crude fibre (14.8%). Amounts of amino acids were on the higher side i.e. tryptophan (116.77mg/100g protein), methionine (181.56mg/100g protein) and lysine (195.67mg/100g protein), as well as total sugars (5.32g/100g) and starch (0.82g/100g). Malting of **finger millet** enhanced the crude protein (7.11%), ash (4.13%), tryptophan (250.13mg/100g protein) and methionine (351.1mg/100g protein) content" [16]. "Ragi is a versatile crop with a high nutrient profile of protein (6-8%), fat (1.3%), calcium (296 mg), carbohydrate (70-76%), lysine (2.86%), tryptophan (1.39%) and methionine (2.86%)" [28].

Finger millet contain the dietary and crude fibers about 18.6% and 4.3%, respectively [29], carbohydrate composition includes 59.5–21.1% starch, 1.4–1.8% cellulose, and 0.04–0.6% lignin [30], starch concentration ranges from 59.4 to 70.2% dry matter, with 80–85% amylopectin and 15% amylose [31], crude protein ranged from 5.6 to 12.70% [32], essential amino acids are phenylalanine (4.1–5.2 g/100 g), histidine (2.2 g/100 g), isoleucine (4.3 g/100 g), leucine (6.6.-9.5 g/100 g), lysine (2.2 g/100 g), methionine (2.5–3.51 g/100 g), threonine (3.4–4.2 g/100 g) while the non-essential amino acids are aspartic acid (6.5–7.90 g/100 g), glutamic acid (20.3–27.1 g/100 g), alanine (6.1–6.2 g/100 g), arginine (2.77–4.5 g/100 g), cystine (1.7–2.5 g/100 g), glycine (2.14–4.0 g/100 g), proline (7.0–9.9 g/100 g), serine (3.6–5.1 g/100 g) and tyrosine (2.79–3.6 g/100 g) [7].

Finger millet has superior keeping qualities than other minor cereals since it has a lower fat content is between 1.3 and 1.8% [29], Free lipids (2.2%), bound lipids (2.4%), and structural lipids (0.6%) make up the total lipid in finger millet [33], . "It contains considerable amount of phosphorus, potassium, magnesium, calcium, sodium, zinc, iron, manganese, and copper in finger millet are 130–283, 430–490, 78–201, 162–398, 49, 2.3, 3.3–14.39, 17.61–48.43, and 0.47 mg/100 g, respectively. Besides it contain vitamins A and B" [7,34].

Health benefits of Finger millets

"Scarcity of protein-rich food and food supplements are responsible for protein-energy malnutrition particularly among children and lactating women in developing countries like India. The World Health Organization (WHO) has identified 4 major forms of malnutrition crippling globally" [35]. "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. It has intensive multifunctional importance(Table 1). 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. It is a rich source of non-available carbohydrates with a low glycemic index, which is beneficial for prevention of diabetes and cardio-vascular diseases. It also helps in delaying

ageing by reducing glycosylation of body proteins" [17]. Besides, it contains essential amino acids and its functions are given in Fig.2.

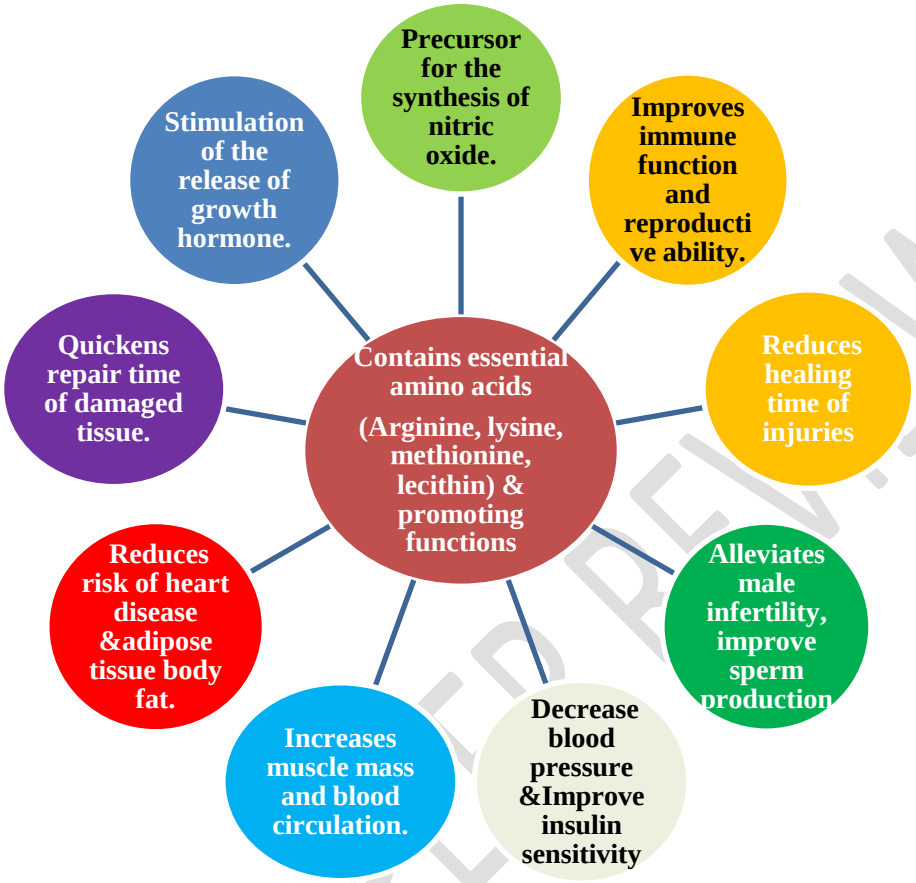

Fig. 2. Essential amino acids presents in finger millet contains and its functions

Table 1. Health Benefits of fi nger millet

S.No.	Benefit	Reference
1.	**Natural weight loss: Contain more fibre and Tryptophane, L**owers your body's blood sugar levels and converts it to insulin	[3]
2.	**Strengthhern bone :** Contains significant amount (344 milligrams) of calcium, important for bone growth	[3]
3.	**Prevent diabetes:** high concentration of dietary fibre and polyphenols, stabilise your blood sugar level, it absorbs starch and decreases your body's ability to digest it. : low glycemic index value: slow down the rate of glucose absorption, which lowers insulin demand	[3,12]

4. **Anti-ageing agent:** contains crucial amino acids like methionine and lysine that shield your skin against the hazards of rashes, wrinkles,and dullness. Contains antioxidants that assist your body battle stress and delay the onset of ageing. contains E which is excellent for your skin [3, 36]
5. **Maintain blood pressure level:** High fiber content, low glycemic index value, improve aortic fragility and elasticity by attenuating elevation of blood pressure and they increase vaso-relaxation [16]
6. **Protect from disease:** anti-inflammatory, antiviral, anticancer and platelet aggregation inhibitory activity [19,37]
7. **Improvement on hemoglobin status in children**: It contains more Iron and Calcium [38,39]
8. **Natural probiotic**: Used as treatment for diarrhea [40]
9. **Improve Digestibility:** Unique property of slower digestibility thereby it is a very good food crop for pregnant women and person who suffering from diabetes. [41]
10. **Boost Lactation:** It contains more amino acid, calcium and iron which are also beneficial for the child. [35]
11. Special therapeutic effects: Contains antioxidative, antiinflammatory, and antimicrobial properties. [42,43]
12. Decreases tumour.: Phytates, phenols and Tannins. [44, 34, 45]
    Lowers body cholesterol, high blood pressure and blood sugar.
    Aids healing and maintenance of ageing and metabolic syndrome.
    Prevents deterioration of human health, cancer and cardiovascular diseases.
13. Prevents cardiovascular diseases such as atherosclerosis antitoxic effect and anticancerous effect: Soluble dietary fibre It possesses hypoglycemic and hypolipidemic effect as well as lowering of serum cholesterol. [45, 46]
14. Lowers associated risk of cardiovascular diseases such as heart attack. It contains considerable amount for Magnesium. [44]
15. Essential for the development of body tissue and energy metabolism: It contains Phosphorus. [47]

CONCLUSION

Cereals and millets are the main sources of food not only for India but also in foreign countries. Among the many types of millet, finger millet is an important staple food in parts of eastern and central Africa and India and it is considered as a poor people's crop. It plays a vital role in maintaining good health, because it includes health benefits due to the presence of several vitamins and minerals. It is easy to digest. Now the trend has changed and consumption of finger millet is increasing in the past few decades. Further wide adoptability of finger millet to soil and climate attack to cultivate many regions in the world. The products made from composite flours are nutritionally superior to their respective controls and can be successfully used for supplementary feeding programmes. Efforts should be made to educate people about the nutritive value and health benefits of finger millet and its food products. Therefore, it is necessary to take steps to increase production and productivity through various improved technologies to meet our requirements in future.

REFERENCE

1. Kumar, A., Metwal, M., Kaur, S., Gupta, A. K., Puranik, S. S., Singh, M., Singh, M., Gupta, S., Babu, B. K., Sood, S., & Yadav, R. Nutraceutical value of finger millet [Eleusine coracana (L.) Gaertn.], and their improvement using omics approaches. *Frontiers in Plant Science*. 2016; 7: 1-14. http://dx.doi.org/10.3389/fpls.2016.00934.
2. Sood, S., Kant, L., & Pattnayak, A. (Finger millet [*Eleusine coracana* (L.) Gaertn.]: a minor crop for sustainable food and nutrition. Mini Review. *Asian Journal of Chemistry*. 2017; 29(4): 707-710. http://dx.doi.org/10.14233/ajchem.2017.20284.
3. Amir Gull, Romee Jan, Gulzar Ahmad Nayik, Kamlesh Prasad and Pradyuman Kumar. Significance of Finger Millet in Nutrition, Health and Value added Products: A Review. Journal of Environmental Science, Computer Science and Engineering & Technology. 2014 ; 3(3): 1601-1608

4. Attuluri Vagdevi, Samalla Trupthi, Mayank Pandey, Nalla Bharath Reddy and Maninder Singh. Nutritional qualities, processing and health benefits of finger millet (Eleusine coracana L.). The Pharma Innovation Journal. 2023; 12(1): 1291-1297
5. Kamini, S. & S. Sarita. Quality Characteristics of Finger Millet Based Baby Food Preparation as Affected by Its Varieties and Processing Techniques. Journal of Functional and Environmental Botany. 2011;1:77-84.
6. Ceasar, S.A., Maharajan, T., Krishna, T.P.A., Ramakrishnan, M., Roch, G.V., Satish, L., Ignacimuthu, S., Finger millet (Eleusine coracana (L.) Gaertn.) improvement: current status future interventions of whole genome sequence. Plant Sci. 2018; 9: 1054
7. Shonisani Eugenia Ramashia, Tonna Ashim Anyasi, Eastonce Tend Gwata, Stephen Meddows-Taylor, Afam Israel Obiefuna Jideani. Processing, nutritional composition and health benefits of finger millet in sub-saharan Africa Food Sci. Technol, Campinas, Apr.-June 2019;39(2): 253-266,
8. Abah, C.R., Ishiwu, C.N., Obiegbuna, J.E., Oladejo, A.A., Nutritional composition, functional properties and food applications of millet grains. Asian Food Science Journal 2020; 14 (2): 9–19.
9. Gopalan C, Ramashastri BV, Balasubramanium SC. Nutritive value of Indian foods. National Institute of Nutrition, ICMR, Hyderabad. 2002.
10. Vijayakumari J, Mushtari BJ, Shamshad B, Sumangala G. Sensory attributes of ethnic foods from finger millet. Paper presented at CCSHAU, Hisar. Recent trends in millet processing and utilization. 2003: 7–12.
11. Gawade, M.B., U.V.Mahadkar And D.N. Jagtap. Effects of organic manures, sources and levels of fertilizers on yield attributes and yield of finger millet (Eleusine coracana G.) International Journal of Agricultural Sciences. 2013;9 (2) : 795-798
12. Ramwant Gupta. Ragi, a boon to nutritional security. 2014. NESA Newsletter
13. Medson, C., Gary, P., Breeding and agronomy. In: Tailor, J., Duodu, K. (Eds.), Sorghum and Millets, second ed. Elsevier publisher2019; pp. 23–50.
14. Dubey A, Verma AKMillets: Good neutraceutical source. Agropedia, 2009:1- 2
15. Kajal Srivastava and A. K. Sharma. Nutraceutical Importance of Finger Millet (Eleusine coracana) for Improved Human Health. The European Journal of Plant Science and Biotechnology. 2012; 6 (2): 91-95

16. Upadhyaya HD, Gowda CLL, Pundir RPS, Reddy VG, Singh S. Development of core subset of finger millet germplasm using geographical origin and data on 14 quantitative traits. Genetic Resources and Crop Evolution. 2006; 53 (4): 679-685
17. Kajal Srivastava and A. K. Sharma.Nutraceutical Importance of Finger Millet (Eleusine coracana) for Improved Human Health. The European Journal of Plant Science and Biotechnology. 2012;(2): 91-95
18. Muthamilarasan, M., Dhaka, A., Yadav, R., Prasad, M., Exploration of millet models for developing nutrients rich graminaceous crops. Plant Sci. 2016; 242: 89–97.
19. Chethan, S., Malleshi, N., Finger millet polyphenols: optimization of extraction and the effect of pH on their stability. Food Chem. 2007;105: 862–870.
20. Devi, P. B., Vijayabharathi, R., Sathyabama, S., Malleshi, N. G., & Priyadarisini, V. B. (2014). Health benefits of finger millet (Eleusine coracana L) polyphenols and dietary fibre – Review. Journal of Food Science and Technology, 6(6), 1021-1040. http://dx.doi.org/10.1007/ s13197-011-0584-9. PMid:24876635.
21. Bravo, L., Polyphenols: chemistry, dietary sources, metabolism and nutritional significance. Nutr. Rev. 1998; 56:317–333.
22. Mgonja, M.A., Lenne, J.M., Manyasa, E., Sreenivasaprasad, S. Finger millet blast management in East Africa. Creating opportunities for improving production and utilization of finger millet. In: Proceedings of the First International Finger Millet Stakeholder Workshop. Projects R8030 & R8445 UK Department for International Development—Crop Protection Programme, (Patancheru: International Crops Research Institute for the Semi-Arid Tropics), 2007: 196.
23. Jagati, P., Mahapatra, I., Dash, D. Finger millet (Ragi) as an essential dietary supplement with key health benefits: a review. International Journal of Home Science.2021;7 (2): 94–100
24. Pragya Singh and Rita Singh Raghuvanshi. Finger millet for food and nutritional security . African Journal of Food Science. 2012; 6(4):77-84.
25. Radhika, G., Sathya, R. M., Ganesan, A., Saroja, R., Vijayalakshmi, P., Sudha, A. Dietary profile of urban adult population in south India in the context of chronic disease epidemiology (CURES-68). Journal of Public Health Nutrition. 2011; 14(4): 591–598.

26. Radhika, G., Van Dam, R. M., Sudha, V., Ganesan, A., & Mohan, V. Refined grain. consumption and the metabolic syndrome in urban Asian Indians (Chennai Urban Rural Epidemiology Study. Metabolism, Clinical and Experimental. 2009;(57-58): 675–681.
27. Pandhre G.R., Satwase A. N. and Syed Imran Hashmi. Studies on drying characteristics and nutritional composition of sprouted wheat and finger millets International Journal of Current Research . 2011; 3(7):218-221,
28. Aparna, K. and Z. G. Ansari. Evaluation of ragi genotypes on growth parameters and physiological attributes under kharif rainfed conditions. *Int. J. of Chemical Studies*, 2017;5(6): 1899-1901
29. Rathore, T., Singh, R., Kamble, D.B., Upadhyay, A., Thangalakshmi, S. Review on finger millet: processing and value addition. The Pharma Innovation Journal. 2019; 8 (4):283–291.
30. Wankhede, D.B., Shehnaj, A., Raghavendra Rao, M.R., Carbohydrates composition of finger millet (Setaria italica). Plant Foods Hum. Nutr. 1979; 28: 293–303.
31. Mittal, M., Development of finger Millet and Barnyard Millet Based Convenience Mixes for Food Products and Their Evaluation for Nutritional Quality, Storage Stability and Acceptability. Thesis. Ph.D. G.B. Pantnagar University of Agriculture and Technology, Pantnagar, 2002: 260.
32. Bhatt, A., Singh, V., Shrotria, P.K., Baskheti, D.C., Coarse Grains of Uttaranchal: Ensuring Sustainable Food and Nutritional Security. Indian Farmer's Digest.2003: 34–38.
33. Sridhar, R., Lakshminarayana, G. Content of total lipids and lipid classes and composition of fatty acids in small millets: foxtail (Setaria italica), proso (Panicum miliaceum), and finger (Eleusine coracana). Cereal Chem. 1994; 71 (4): 355–358.
34. Siwela, M., Taylor, J.R.N., de Milliano, W.A.J., Doudu, K.G., 2007. Occurrence and location of tannin in finger millet grain and antioxidant activity of different grain types. Cereal Chem. 84 (2), 169–174.
35. WHO. Energy and Protein Requirements, WHO technical Report Series No. 724, World Health Organization, Geneva WHO/FAO Report. 1985: 1- 206
36. Rajasekaran, N. S., Nithya, M., Rose, C., &Chandra, T. S. The effect of finger millet feeding on the early responses during the process of wound healing in diabetic rats. Biochimica et Biophysica Acta.2004; 1689; 190–201.

37. Varsha, V., Urooj, A., & Malleshi, N. G. Evaluation of antioxidant and antimicrobial properties of finger millet (Eleusine coracana) polyphenols. Food Chemistry. 2009; 114(1): 340–346.
38. Tatala, S., Ndossi, G., Ash, D., & Mamiro, P. Effect of germination of finger millet on nutritional value of foods and effect of food supplement on nutrition and anaemia status in Tanzanian children. Tanzania Health Research Bulletin.2007; 9(2): 77–86.
39. Devulapalli Sharat Dhruthi1, Devaki Gokhale. Nutritional Impact of Millet-based Foods on Pregnant and Nursing Women from Anganwadi Centers in Mahabubnagar. International Journal of Nutrition, Pharmacology, Neurological Diseases. 2022; 12(2): 66-71.
40. Lei, V., Friis, H., & Michealsen, K. F. Spontaneously fermented finger millet product as a natural probiotic treatment for diarrhea in young children: An intervention study in Northern Ghana. International Journal of Food Microbiology. 2006; 110:246–253.
41. Watt, J.M., and Breyer-Brandwijk, M.G. The Medicinal and Poisonous Plants of Southern and Eastern Africa, Second edition, E. and S. Livingstone Ltd, Edinburgh and London; 1962: 1457.
42. Banerjee, S., Sanjay, K.R., Chethan, S., Malleshi, N.G. Finger millet (Eleusine coracana) polyphenols: investigation of their antioxidant capacity and antimicrobial activity. Afr. J. Food Sci. 2012; 6: 362–374.
43. Shahidi, F and Chandrasekara, A. Millet grain phenolics and their role in disease risk reduction and health promotion: a review. J. Funct.Foods 2013; 5 (2): 570–581.
44. Chandra, A., Singh, A.K., Mahto, B., 2018. Processing and value addition of finger millet to achieve nutritional and financial security – case study. International Journal of Current Microbiology and Applied Sciences 7, 2901–2910
45. Thilagavathi, T., Banumathi, P., Kanchana, S., Ilamaran, M., 2015. Effect of heat moisture treatment on functional and phytochemical properties of native and modified millet flours. Plant Archives 15 (1), 15–20.
46. Udeh, H.O., Duodu, K.G., Jideani, A.I.O. Finger millet bioactive compounds, bioaccessibility and potential health effects – a review. Czech J. Food Sci. 2017; 35: 7–17.

47. Abioye V.F., Babarinde G.O., Ogunlakin G.O., Adejuyitan J.A., Olatunde S.J., Abioye A.O.. Varietal and processing influence on nutritional and phytochemical properties of finger millet: A review. Heliyon . 2022; 8: e12310