International Journal of Home Science 2016; 2(1): 151-155

International Journal of Home Science

ISSN: 2395-7476
IJHS 2016; 2(1): 151-155

www.homesciencejournal.com
Received: 08-12-2015
Accepted: 10-01-2016

Dr. Ekta Singh
Associate Professor, Department of food science and nutrition, Banasthali University, Tonk, Rajasthan, India
Email: ers_shyam@yahoo.co.in

Sarita
Department of food science and nutrition, Banasthali University, Tonk, Rajasthan, India
Email: sarita6jadaun6@gmail.com

Correspondence
Dr. Ekta Singh
Associate Professor, Department of food science and nutrition, Banasthali University, Tonk, Rajasthan, India
Email: ers_shyam@yahoo.co.in

Potential functional implications of finger millet (*Eleusine coracana*) in nutritional benefits, processing, health and diseases: A review

Ekta Singh, Sarita

Abstract
Dietary quality should be taken into consideration for maintaining overall maximization of human health and solving the problem of deep rooted food insecurity and malnutrition so millet has good option to overcome it. Millets are small seeded and minor cereals of the grass family (Poaceae) and are characterized by their ability to survive in less fertile soil, resistance to pests and diseases, drought-resistant, short growing season. Finger millet is one of the ancient millet crop cultivated in several regions of India. Finger millet is rich source of carbohydrate. Finger millet protein contains major fractions of prolamins that have higher proportion of glutamic acid, proline, valine, isoleucine, leucine and phenylalanine and low lysine, arginine and glycine. Sulfur containing amino acids in finger millets are higher (methionine and cystine) as compared to milled rice. Potassium content is also high in finger millet. Finger millet has high calcium content (350 mg/ 100 g). Milled finger millet is rich in dietary fiber and micronutrients. Finger millet's fat consist oleic acid, linoleic acid, palmitic acid and traces of linolenic acid. Layers of Seed coat of the finger millets contain tannins and polyphenols. Phenolic compounds (both free and bound forms) are present in very good amount in finger millet. Several flavonoids such as orientin, isoorientin, vitexin, isovitexin, saponarin, violanthin, lucenin-1 and tricin (antitumour and anti-leukemic properties) founded in finger millet's leaves. Finger Millet has antioxidant, antimicrobial and antihypocholestrolemic, antifungal and antibacterial, antidiabetic (type 2 diabetes), nephroprotective, wound healing and anticataractogenesis properties. Food processing techniques are used to enhance nutritional quality, improve the digestibility and bioavailability of food nutrients with reducing anti-nutrients. Some food techniques are decortications, milling, soaking, cooking, germination, fermentation, malting, popping etc. Combination of germination and malting can be used for preparation of variety of healthy and nutritious food products such as infant formula, complementary food products and therapeutic foods to combating health problem. Finger millet is staple food substitute for celiac patients because it has gluten-free properties.

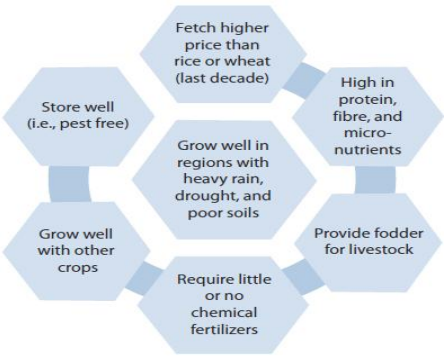
Keywords: finger millet, gluten-free foods, popping, germination, antioxidants

Introduction
The nutritional status of a community has been recognized as an important indicator of national developments. Therefore, agricultural products must be introduced to people as nutritional food which are underutilized and ignored by us. Cultivation of millets and promotion for its utilization will be one of the successful potential approaches for improving the nutritional status and human health specifically in financially weaker population. Dietary quality should be taken into consideration for solving the problems related to deep rooted malnutrition and health problems (Singh & Raghuvanshi, 2012) [27].

Millets have been found to have high nutritive values and are comparable to other major cereals like wheat and rice. It is reported that major consumption of cereals provide 70-80% of total energy in majority of Indian diets and millets contribute to only about 2% of total calorie (Radhika *et al.*, 2011) [20] because millets are commonly used as animal feed. Millets can be used as nutraceutical and to produce healthier food for nourishing.

Millets are classified into two as major millets and minor millets. It is reported by Yang *et al.*, (2012) [32] that Finger millet (*Eleusine coracana*), Pearl millet (*Pennisetum glaucum*), Foxtail millet (*Setaria italic*) are included in major millets and Kodo millet (*Paspalum scrobiculatum*), Little millet (*Panicum sumatrense*), Barnyard millet (*Echinochloa spp.*), Browntop millet (*Urochloa ramosa*), Guinea millet (*Brachiaria deflexa*), Teff (*Eragrostis tef*) and Fonio (*Digitaria exilis*), Sorghum (*Sorghum spp.*) are minor millets (Adekunle, 2012) [1].

FIGURE 1: Why millets?



Nutritional properties in finger millet

Finger millet (*Eleusine coracana L.*) is also known as ragi and mandua (India). Finger millet is a good source of nutrients especially of calcium, iron, phosphorus, zinc, potassium, other minerals and fibre. Dykes and Rooney, (2007) [7] have reported that finger millet is a very good source of variety of phenolic compounds which may have health benefits. The main polyphenols are phenolic acid and tannins (Shobana *et al*., 2013) [26] while flavonoids are present in small quantities (Rao and Muralikrishna, 2002) [22]. Polyphenols has been known to impart antimicrobial (Viswanath *et al*., 2009) [30], anti-diabetic, antimutagenic properties. Along these, functional property (gelatinization) is also present in finger millet (Mathanghi & Sudha, 2012) [17].

Finger millets contain 1.85-2.10% of total lipids & consist of 70-72% neutral lipids mainly triglycerides, 10-12% of glycolipids and 5-6% of phospholipids. Finger millet's fat consist oleic acid, linoleic acid, palmitic acid and traces of linolenic acid. Gopalan *et al*., (2009) [9] reported finger millet is rich source of calcium (344 mg) as compared to all other cereals and millets. Finger Millet also contains 283 mg phosphorus & 3.9 mg iron.

NUTRITIONAL BENEFITS OF MILLETS

For 100g of each cereal :

	Proteins (g)	Fiber (g)	Minerals (g)	Iron (mg)	Calcium (mg)
Pearl millet	10.6	1.3	2.3	16.9	38
Finger millet	7.3	3.6	2.7	3.9	344
Foxtail millet	12.3	8.0	3.3	2.8	31
Proso millet	12.5	2.2	1.9	0.8	14
Kodo millet	8.3	9.0	2.6	0.5	27
Little millet	7.7	7.6	1.5	9.3	17
Barnyard millet	11.2	10.1	4.4	15.2	11
Rice	6.8	0.2	0.6	0.7	10
Wheat	11.8	1.2	1.5	5.3	41

Source : Millet Network of India (http://milletindia.org)

Seed	Protein(g)	Fat (g)	Ash (g)	Crude Fibre(g)	Carbs (g)	Energy Kcal	Ca Mg	Fe Mg	Thiamin Mg	Riboflavin Mg	Niacin Mg
Rice (brown)	7.9	2.7	1.3	1.0	76.0	362	33	1.8	0.41	0.04	4.3
Wheat	11.6	2.0	1.6	2.0	71.0	348	30	3.5	0.41	0.10	5.1
Maize	9.2	4.6	1.2	2.8	73.0	358	26	2.7	0.38	0.20	3.6
Sorghum	10.4	3.1	1.6	2.0	70.7	329	25	5.4	0.38	0.15	4.3
Pearl Millet	11.8	4.8	2.2	2.3	67.0	363	42	11.0	0.38	0.21	2.8
Finger Millet	7.7	1.5	2.6	3.6	72.6	336	350	3.9	0.42	0.19	1.1
Foxtail Millet	11.2	4.0	3.3	6.7	63.2	351	31	2.8	0.59	0.11	3.2
Proso Millet	12.5	3.5	3.1	5.2	63.8	364	8	2.9	0.41	0.28	4.5
Little millet	9.7	5.2	5.4	7.6	60.9	329	17	9.3	0.30	0.09	3.2
Barnyard millet	11.0	3.9	4.5	13.6	55.0	300	22	18.6	0.33	0.10	4.2
Kodo millet	9.8	3.6	3.3	5.2	66.6	353	35	1.7	0.15	0.09	2.0

The quality of food nutrient depends on its composition, digestibility and bioavailability, but it is limited by structural characteristics and certain anti-nutritional factors. Some varieties of processing methods have been practiced to maximize the use of nutrients through reducing of anti-nutritional factors such as soaking, germination, malting, cooking etc.

Health benefits of finger millets

Incorporation of finger millets into the diets has preventive potential from chronic disease reported by Kannan (2010) [12]. Tatala, *et al*., (2007) [28] founded the improvement in children on level of hemoglobin after feeding finger millet-based food. Potential health benefits of finger millet are:

GOURGANIC

1. Finger millets and diabetes

Finger millet feeding controls blood glucose level improves antioxidant status (Hedge *et al*., 2005) [11] and hastens the dermal wound healing process in diabetic rats (Rajasekaran *et al*., 2004) [21]. Finger millet based diet response to lower glycemic effect due to the presence of antinutritional factors which reduce starch digestibility and absorption (Kumari, *et al*., 2002) [13]. Finger millet seed coat phenolics act as inhibitors decreasing the postprandial hyperglycaemia by blocking the action of enzymes (amylase, alpha-glucosidase) needed for hydrolysis of complex carbohydrates.

2. Finger millets and cardiovascular disease

Lee, *et al*., (2010) [14] investigated that finger millet may prevent cardiovascular disease by reducing plasma triglycerides in hyperlipidemic rats. Finger millet has lower concentration of serum triglycerides.

3. Finger millets and celiac disease

Celiac disease is an immune-mediated enteropathy triggered by the ingestion of gluten in genetically susceptible individuals. Finger millets is gluten-free, therefore an excellent option for people suffering from celiac diseases and gluten-sensitive patients often irritated by the gluten content of wheat and other more common cereal grains (Saleh *et al*., 2013) [24].

4. Finger millets and cancer

Chandrasekara, *et al*., (2011c) [3] demonstrated that phenolics of millets may be effective in the prevention of cancer initiation and progression in vitro. Coulibaly, *et al*., (2011) [6] founded that phytate present in millets are associated with reduction in cancer risk.

5. Finger millets and anti-Inflammatory activity

Rajasekaran *et al*., (2004) [21] have reported good antioxidant effects of finger millet on the dermal wound healing process in diabetes induced rats with oxidative stress-mediated modulation of inflammation.

6. Finger millets and aging

Millet grains are rich sources of antioxidants and phenolics that contribute importance in health, aging and metabolic syndrome. It has been found that finger millets inhibit glycation and cross-linking of collagen to usefulness in the protection against aging (Hegde, *et al*., 2002) [10].

7. Finger millet and cataractogenesis

Chethan, *et al*., (2008) [5] showed that finger millet seed coat phenolics such as gallic, vanillic, syringic, ferulic, quercetin, trans-cinnamic, p-coumaric, protocatechuic and p-hydroxybenzoic were identified for inhibiting cataract of the eye lens to inhibit reversibly aldose reductase *sniger*.

8. Finger millets and antimicrobial Activity

Protein extracts of millets were highly effective to inhibit the growth of pathogenic fungi such as Rhizoctonia solani, Macrophomina phaseolina and Fusarium oxysporum (Radhajeyalakshmi, *et al*., 2003) [19]. Xu, *et al*., (2011) [31] founded that millet's polyphenols content showed antibacterial and antifungal activity.

9. Finger millet and antibacterial activity

Banerjee, *et al*., (2012) [2] founded that phenolic content and flavonoids of finger millet inhibit oxidation of microbial membranes and microbial enzymes leading to inhibitory activities of proliferation of bacterial cells such as E. coli, B. cereus, Listeria monocytogenes, Staphylococcus aureus, Streptococcus pyogenes, Serratiamarcescens, Proteus mirabilis, Pseudomonas aeruginosa, Klebsiella pneumonia and Yersinia enterocolitica.

Anti-nutrients present in millets

Millets are excellent source of nutrients value but in the other hand, nutritional quality is considerably lowered by the presence of anti-nutrients which are the major phytochemicals which negatively affects its nutritive values leading to poor digestibility of proteins, carbohydrate and low bioavailability of minerals such as calcium and magnesium and trace elements such as zinc, iron and copper. Millets contain anti-nutrients such as tannin, polyphenols, phytates, oxalic acid, digestive enzymes inhibitors (amylase inhibitor activity, trypsin inhibitor activity), goitrogens etc. Polyphenols are reducing agents that protect the body's tissues against oxidative stress. It referred to as antioxidants, they may prevent various diseases associated with oxidative stress, such as inflammation, cancers, cardiovascular diseases etc. They are the most abundant antioxidants in our diets (Scalbert)

The proportion of these Anti-nutrients in diet can be reduced by various household processing techniques such as decortications, malting, germination fermentation, popping etc. Germination effects on trypsin inhibitor activity, tannins, phytates. Fermentation reduces the reduction of components like phytates, phenol, tannins and trypsin inhibitor activity.

Food Processing Techniques

Germination

It is a biochemical process which involves transition of a seed from dormant state to vital active state. Germination can increase protein content, mineral bioavailability and dietary fibre. It reduces anti nutrients like tannin, phytic acid content and polyphenols (Ghavidal and Prakash, 2007) [8]. Controlled germination conditions provide high quality of malt products. Malting increases the nutrient content and digestibility of food (Platel *et al*., 2010) [18]. Germination with other processing treatments to prepare malt rich nutrients can be used for preparation of several healthy and nutritional food products.

Fermentation

The fermentation decreases the starch and long-chain fatty acid content, leading to an increase microbial flora, lactic and acetic acid contents, respectively. The total fat content

decreased which favorably agrees with total loss in long-chain fatty acid content. The germinated (72 h) finger millet fermented (10 days) with *M. purpureus* showed reduction in phytic acid and tannin contents by 88.8% and 90.1%, respectively, with an increase of 61.5% minerals, reducing sugars and soluble proteins thereby supporting the production of antihypercholesterolemic metabolite, statin (Venkateswaran & Vijayalakshmi, 2010) [29].

Popping or puffing

Pooping is a traditional, simple and least expensive method of preparing ready to consume cereal products. Popping brings about several physicochemical changes in its starch and loss of birefringence. Puffed millet influences product quality, such as puffed yield, expansion volume, bulk density, nutritive content and functionality. For promoting utilization of millets with optimization of conditions, popping technique can be used as a strategy or in combination with other pre-treatments to produce ready-to-eat expands of millet grains at the commercial level.

Millets As food products

Chandrasekara, *et al*., (2012) [4] reported that in African and Asian areas, millets are receiving specific attention as a major food component, serve as various traditional foods and beverages like porridges, bread (fermented or unfermented) and various snack foods are made up from millet, especially in non-affluent segment of society. As natural probiotic treatment by fermented finger millet drink for diarrhea was reported by Lei *et al*. (2006) [15]. Roopa and Premavalli (2008) [23] studied the effect of puffing showed mild increase in the rapidly digestible starch in finger millet.

Utilization of millets are suitable for large scale food products such as millet wine, millet nutrition powder from both grain and flour form (Liu, *et al*., 2012) [16]. Combination of germination and malting can be used for preparation of variety of healthy and nutritious food products such as infant formula, complementary food products in promoting millet utilization. In Nigeria, kunu is nutritious beverage that gives highest nourishment to the body. It is a good source of energy because of high amount of protein, normal total solids, moderate pH and acidity (Saleh, *et al*., 2013) [24].

Conclusion

The cereals are staple food source consumed by millions of people that is not only providing major nutrients like protein, carbohydrate, fat etc. But millets provide ample of vitamins and minerals. Occurrence of malnutrition and various health problems such as diabetes, obesity, CVD, cancer, celiac disease etc. are most prominent in developing countries, because of inadequate supply of nutrition. This is mainly due to the little utilized agricultural crops as food product and unawareness of people. The importance of this study undertakes to concern developing agenda specific to these crops which must be recognized as an important food.

Finger millets contain many health-promoting components such as good protein, carbohydrate, fat, dietary fibre, vitamins and minerals as well as antioxidant and phytochemicals. The aim of this study is to introduce the finger millets as a nutritious food, fulfillment of the nutritional need of global population and to find ways to utilize the millets effectively, nutritionally and to alleviate the problems of malnutrition and other health problems.

This study focused to improve the nutrients of millets for nourishing the health and reducing some anti-nutrients which reduces the acceptability, digestibility and bioavailability of nutrients. Household food processing strategies are used for improving the nutritional quality to promote finger millet utilization for future prospective and to help in nourishing the common population and to help in preventing and curing the diseases.

This study emphasized on nutraceutical properties of finger millets and the application of millets as alternative of cereals potentially healthy to elaborate therapeutic food products such as gluten free diet, protein and energy rich diet, diet for diabetes, CVD, etc. This study showed that millets are used as "food medicine". Finger millet is source of antioxidants such as phenolic acids and glycated flavonoids. Millet foods are also characterised to be potential prebiotic and can enhance the viability of probiotics with potential health benefits.

Reference

1. Adekunle AA. Agricultural Innovation in Sub-Saharan Africa: Experiences from Multiple Stakeholder Approaches. Forum for Agricultural Research in Africa, Ghana, 2012. ISBN 978-998-8373-2-4.
2. Banerjee S, Sanjay K, Chethan S, Malleshi NG. Finger millet (Eleusinecoracana) polyphenols: Investigation of their antioxidant capacity and antimicrobial activity. African Journal of Food Science. 2012; 6:362-374.
3. Chandrasekara A, Shahidi F. Antiproliferative Potential and DNA Scission Inhibitory Activity of Phenolics from Whole Millet Grains. J. Funct. Foods. 2011c; 3:159-170.
4. Chandrasekara A, Shahidi F. Bioaccessibility and Antioxidant Potential of Millet Grain Phenolics as Affected by Simulated in Vitro Digestion and Microbial Fermentation. J Funct Foods. 2012; 4:226-237.
5. Chethan S, Dharmesh SM, Malleshi NG. Inhibition of Aldose Reductase from Cataracted Eye Lenses by Finger Millet (Eleusine Coracana) Polyphenols. Bioorg. Med. Chem. 2008a; 16:10085-10090.
6. Coulibaly A, Kouakou B, Chen J. Phytic Acid in Cereal Grains: Structure, Healthy or Harmful Ways to Reduce Phytic Acid in Cereal Grains and their Effects on Nutritional Quality. Am. J Plant Nutr Fert Technol. 2011; 1:1-22.
7. Dykes L, Rooney LW. Phenolic Compounds in Cereal Grains and their Health Benefits. Cereal Foods World 2007; 52(3):105-111.
8. Ghavidel RA, Prakash J. The Impact of Germination and Dehulling on Nutrients, Antinutrientsin Vitro Iron and Calcium Bioavailability and in Vitro Starch and Protein Digestibility of Some Legume Seeds. Intern. LWT. 2007; 40(7):1292-1299.
9. Gopalan C, Rama Sastri BV, Balasubramanian SC. Nutritive value of Indian foods. Hyderabad, India: National Institute of Nutrition, Indian Council of Medical Research, 2009.
10. Hegde PS, Chandrakasan G, Chandraa TS. Inhibition of Collagen Glycation and Crosslinking in Vitro by Methanolic Extracts of Finger Millet (Eleusine coracana) and Kodo Millet (Paspalum scrobiculatum). J Nutr Biochem. 2002; 13:517-21.
11. Hegde PS, Rajasekaran NS, Chandra TS. Effects of the Antioxidant Properties of Millet Species on Oxidative Stress and Glycemic Status in Alloxan-Induced Rats. Nutr. Res. 2005; 25:1109-1120.
12. Kannan S. Finger millet in nutrition transition: An infant weaning food ingredient with chronic disease preventive potential. British Journal of Nutrition. 2010; 104:1733-

1734.
13. Kumari PL, Sumathi S. Effect of consumption of finger millet on hyperglycemia in non-insulin dependent diabetes mellitus (NIDDM) subjects. Plant Foods Hum Nutri. 2002; 57:205-13.
14. Lee SH, Chung I-M, Cha Y-S, Parka Y. Millet Consumption Decreased Serum Concentration of Triglyceride and C - reactive protein But Not Oxidative Status in Hyperlipidemic Rats. Nutr. Res. 2010; 30:290-296.
15. Lei V, Friis H, Michaelsen KF. Spontaneously Fermented Millet Product as a Natural Probiotic Treatment for Diarrhea in Young Children: An Intervention Study in Northern Ghana. Int. J Food Microbiol. 2006; 110:246-253.
16. Liu J, Tang X, Zhang Y, Zhao W. Determination of the volatile composition in brown millets, milled millet and millet bran by gas chromatography / mass spectrometry. Molecules. 2012; 17:2271-82.
17. Mathanghi SK, Sudha K. Functional and Phytochemical Properties of Finger Millet (Eleusina corana L.) for Health. Intern. J Pharma Chem and Bio Sci. 2012; 2(4):413-438.
18. Platel K, Eipeson SW, Srinivasan R. Bioaccessible Mineral Content of Malted Finger Millet (Eleusine Coracana), Wheat (Triticum Aestivum), and Barley (Hordeum Vulgare). J Agric Food Chem. 2010; 58:81003.
19. Radhajeyalakshmi R, Yamunarani K, Seetharaman K, Velazhahan R. Existence of Thaumatin-Like Proteins (Tlps) in Seeds of Cereals. Acta Phytopathol Entomol Hungarica. 2003; 38(3, 4): 251-257.
20. Radhika G, Sathya RM, 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). J Public Health Nut 2011; 14(4):591-598.
21. Rajasekaran NS, Nithya M, Rose C, Chandra TS. The Effect of Finger Millet Feeding on the Early Responses during the Process of Wound Healing in Diabetic Rats. Biochim. Biophys. Acta. 2004; 1689:190-201.
22. Rao M, Muralikrishna G. Evaluation of the Antioxidant Properties of Free and Bound Phenolic Acids from Native and Malted Finger Millet (Ragi, Eleusine coracana Indaf-15). J Agric Food Chem. 2002; 50:889-892.
23. Roopa S, Premavali KS. Effect of processing on starch fractions in different varieties of finger millet. Food Chemistry. 2008; 106(3):875-882.
24. Saleh ASM, Zhang Q, Chen J, Shen Q. Millet Grains: Nutritional Quality, Processing, and Potential Health Benifits. Comprehensive Reviews in Food Science and Food Safety. 2013; 12:281-295.
25. Scalbert A, Williamson G. Chocolate: Modern science investigates an ancient medicine.
26. Shobana S, Krishnaswami K, Sudha V, Malleshi NG, Anjana RM, Palaniappan L, Mohan V. Finger Millet (Ragi, *Eleusine Coracana L.*): A Review Of Its Nutritional Properties, Processing, and Plausible Health Benifits. Advance in Food and Nutrition Research. 2013; 69:1-3.
27. Singh P, Raghuvanshi RS. Finger Millet for Food and Nutrition Security. African Journal of Food Science. 2012; 6(4):77-84.
28. Tatala S, Ndossi G, Ash D, Mamiro P. Effect of germination of finger millet of 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.
29. Venkateswaran V, Vijayalakshmi G. Value addition to finger millet (Eleusine coracana) by germination and fermentation with Monascus purpureus. International journal of food science and nutrition. 2010; 61(7):722-727.
30. Viswanath V, Urooj A, Malleshi NG. Evaluation of Antioxidant and Antimicrobial Properties of Finger Millet Polyphenols (Eleusine Coracana). Food Chem. 2009; 114(1):340-346.
31. Xu W, Wei L, Qu W, Liang Z, Wang J, Peng X *et al.* A novel antifungal peptide from foxtail millet seeds. J Sci Food Agri. 2011; 91:1630-1637.
32. Yang X, Wan Z, Perry L, Lu H, Wang Q, Hao C *et al.* Early Millet Use in Northern China. Proc. Nat. Acad. Sci. USA. 2012, 1-5.