Overview on Nutritional and Phytochemical Composition of Finger Millet (*Eleusine Coracana*): A Review

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Abstract— *This review focuses on overview of nutritional and phytochemical composition of Finger millet (Eleusine coracana). Finger millet is also known as Ragi or mandua in India, which is one of the minor cereal crop largely grown in Asian and African regions of the world. It is well known for its health benefits due to the presence of macro and micro nutrients (carbohydrates, fats, proteins, dietary fibers, vitamins, minerals) as well as phytochemicals (Tannins, steroids, polyphenols, alkaloids, terpenoids, cardiac glycosides, balsams, lignans, phytooestrogens, phytocyanins, Gallic acid, ferulic acid, quercetin, vanillic acid, caffeic acid, sinapic acid, quercetin and proanthocyanidins) in correct proportion. Being staple food in India, it is highly advantageous to low income group people. Studies have concluded its effectiveness against lipid per oxidation, ageing, diabetes, hyperactivity, wounds, cancer and osteoporosis. Therefore, the need of value addition of finger millet is highly needed to combat growing issues in children as well as in aged people*.

Keywords— Finger millet, nutritional, phytochemical, health benefits, value addition.

I. INTRODUCTION

Millets are small seeded annual cereal crop species belonging to family "poaceae". Millet is a French derived word "mille" which means thousand (Ramashia *et al*., 2019). One of the wonder varieties of millet family is Finger millet (*Eleusine coracana*) which is commonly popular as *Ragi* or *mandua*in India belonging to grass family Gramineae or Poaceae (Singh, 2012). It is native from Ethiopia region but largely grown in Asia and Africa regions of the world.It is a self pollinated crop species with chromosome no. 36 (allotetraploid) distributed in about 10 genera and 20 species in all (Kakri *et al*., 2020). Finger millet grains are globular in shape of 1.0 to 1.5 mm in diameter. The finger millet kernel consists of 3 main parts namely; seed coat, endosperm and embryo. The outermost layer of the millet is known as pericarp or glume (Ramashia *et al*., 2019) which has little nutritional significance. The seed coat or the testa of finger millet is multilayered (five layered) making it unique as compared to other members of the millet family. The seed coat, germ, and the endosperm cell walls of the millet are endowed with poly phenols making it rich in phytochemicals (Shobana *et al*., 2013). The crop was cultivated around 5000 years BC and still is one of the most produced grain species worldwide. Finger millets stands sixth in production in India and fourth in the world after major crops such as wheat, rice, maize, sorghum and bajra (Chandra *et al*., 2016). India is the largest producer of finger millet accounting to about 60% of world production followed by Ethiopia (Gull *et al*., 2014). Finger millet is a staple food to many parts of the world primarily in developing countries. It is popular among the low income groups of society and is considered as poor man's food (Maharajan *et al*., 2021). It is majorly grown in dry areas in tropical and sub tropical regions with temperature requirement of 8-10 degree Celsius (Singh, 2012) with acidic soil (alluvial, loamy, and sandy) and higher rainfall of 600- 1200 cm, matures within a time span of 100-130 days (Gull et al., 2014). It has several varieties (yellow, white, tan, red, brown, or violet color) and apart from all the varieties, red colored variety is mostly cultivated all over the world (Chandra *et al*., 2016). Finger millet is associated with number of health benefits such as antioxidant, anti-ageing, anti- diabetic, hyperactivity, healing property, anticancer property (Antony Cesar *et al*., 2018) and

maintaining bone health for which it is gaining importance in the field of health and nutrition. This review focuses to get insights of nutritional and health prospects of finger millet (*Eleusine coracana*) so that value added products can be made out of it.

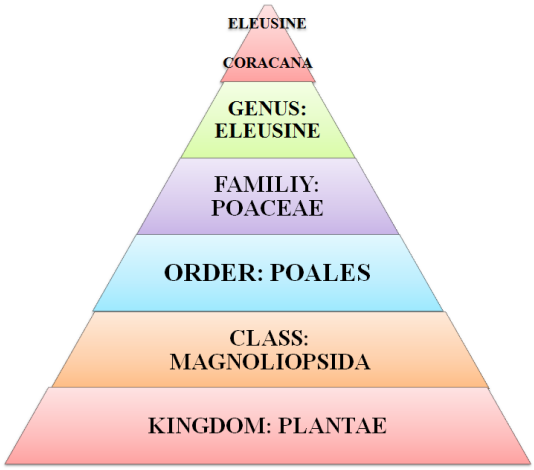


FIGURE 1: Hierarchical classification of finger millet

FIGURE 2: Finger millet

1.1 Nutritional significance of Finger millets:

Finger Millets are nutritionally superior to other cereal crops of same variety such as rice and wheat because it serves as an excellent source of carbohydrate (80%), proteins (7–9%) with essential amino acids as well as non essential amino acids like valine, methionine, and tryptophan, minerals (calcium, phosphorus, potassium, and iron) as well as vitamins (thiamine, niacin, and riboflavin), and fats for which they are extensively been researched (Murtaza *et al.*, 2014).

TABLE 1
GENERAL COMPOSITION OF FINGER MILLETS PER 100G

Sr. No.	Parameter	Composition (g)	Sources
1	Carbohydrates	72.6	Kakri *et al*., 2020
2	Proteins	7.7	
3	Fats	1.5	Kumar *et al*., 2016
4	Crude fiber	3.6	
5	Dietary fiber	15-22	Ramashia *et al*., 2019
6	Energy (Kcal)	336	

1.2 Mineral and vitamin profile of finger millets:

Finger millet is found to be rich in vitamins as well as some minerals, which prove its significant utilization in human diets as well. Vitamins such as vitamin A (Retinol), vitamin B1 (Thiamine), vitamin B2 (Riboflavin), vitamin B3 (Niacin), vitamin C (Ascorbic acid) and minerals (phosphorous, potassium, magnesium, calcium, sodium, iron and zinc) are abundantly found in finger millet at valuable composition.

TABLE 2
MINERAL AND VITAMIN COMPOSITION OF FINGER MILLETS (*ELEUSINE CORACANA*) PER 100G

Sr. No.	Nutrients	Composition mg/100g	Sources
1	Phosphorus	130-250	USDA, 2016
2	Potassium	430- 490	
3	Magnesium	78- 201	
4	Calcium	398	Patel *et al*., 2014
5	Sodium	11	
6	Iron	3.9	Muthamilarasan *et al*., 2016
7	Zinc	2.3	
	Vitamins		
1	Vitamin B2 (Thiamine)	0.12- 0.42	Ramashia *et al*., 2019
2	Vitamin B1 (Riboflavin)	0.2-0.48	
3	Vitamin B3(Niacin)	1.0-1.30	Devi *et al*., 2011
4	Vitamin C (Ascorbic acid)	1.0	
5	Vitamin A (Retinol)	6.0	

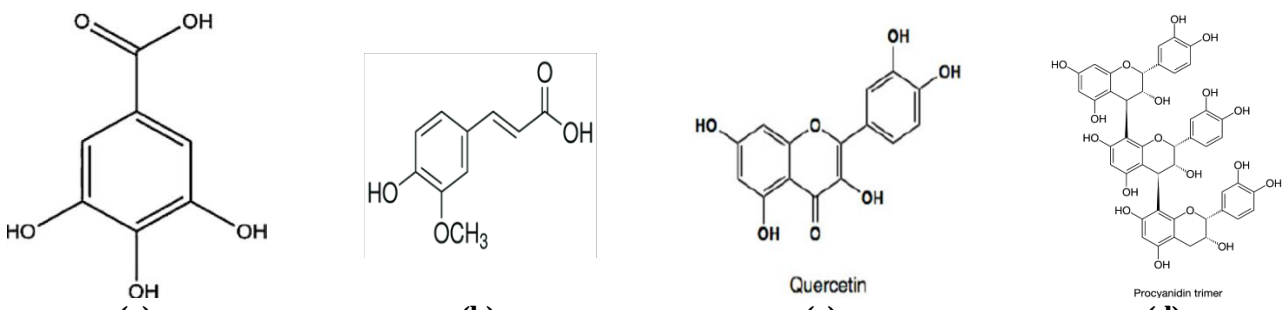
1.3 Amino acid profile of Finger millet (*Eleusine coracana*):

Finger millet is a complete source of essential as well as non essential amino acids which are required by human body in sufficient amount for proper growth and development of body cells. Essential amino acids such as Valine (4.9-6.9g), methionine (2.5-3.1g), tryptophan (1.1-1.5), Phenyalanine (4.1- 5.2g), histidine (2.2), isoleucine (4.3g), leucine (6.6-9.5g), threonine (3.4- 4.2g) and non essential amino acids such as Aspartic acid (6.5- 7.9g), glutamic acid (20.3- 27.1g), alanine (6.1- 6.2g), arginine (2.77- 4.5g), cystine (1.7- 2.6g), glycine (2.14- 4.0), proline (7.0- 9.9), serine (3.6- 5.1g) and tyrosine (2.79- 3.6g) are found in Finger millet (Ramashia *et al*., 2019; Thapliyal and Singh, 2015).

1.4 Phytochemical composition:

Finger millet is found to be rich in certain phytochemicals such as Tannins, steroids, polyphenols, alkaloids, terpenoids, cardiac glycosides, balsams, lignans, phytooestrogens and phytocyanins. Some phenolic acid derivatives (Hydroxybenzoic Gallic acid, protocatechuic acid, p-hydroxybenzoic acid, vanillic acid, syringic acid), hydroxycinnamic acid derivatives (Ferulic acid, trans—cinnamic acid, p- coumaric acid, caffeic acid, sinapic acid) and some flavonoids such as Quercetin , Proanthocyanidins and condensed tannins (Devi *et al*., 2011), which are important in healing, aging, prevents deterioration of human health, lowers blood pressure, lowers risk of diabetes, and helps combating the metabolic syndromes (Thilagavathi *et al*., 2015).

1.5 Chemical structures of major phytochemicals present



(a) (b) (c) (d)

FIGURE 3: a) Galic acid, b) Ferulic acid, c) Quercetin d) Proanthocyanidins

1.6 Potential health benefits of Finger millet (*Eleusine coracana*):

1.6.1 Anti-oxidant activity

Studies have concluded that, oxidation of cellular molecules (by reactive oxygen and nitrogen species) has been linked with chronic diseases such as diabetes, heart disease, cancer, and several other normal functions in humans. Dietary plant polyphenols act for reduced risk of cancer, cardiovascular and neuro-degenerative diseases, infections, ageing, and diabetes (Kumar *et al*., 2016). Seed coat of finger millet grains is high in phenolic compounds (mostly benzoic acid derivatives) that have been shown to have "antioxidant activity". On average, white finger millet contains 0.04–0.09% polyphenols, while brown finger millets contain 0.08–3.47 %. A major fraction of benzoic acid derivatives (gallic acid, protocatechuic acid, p-hydroxybenzoic acid, vanillic acid, syringic acid), while the rest was either cinnamic acid derivatives (ferulic acid, trans-cinnamic acid, p-coumaric acid, caffeic acid, sinapic acid) or flavonoids (Chethan and Malleshi, 2007) are derived, which are found to be effective against cancer, cardiovascular and neuro-degenerative diseases, infections, ageing, and diabetes. Finger millet is also reported to have inhibition of collagen cross- linking property which reduces the stiffness of elastic tissues in tendons, skin and blood vessels as well (Kumar *et al*., 2016).

1.6.2 Anti-diabetic properties

Diabetes also known as "Diabetes mellitus" is a major health concern that is rapidly increasing in India and several other developing as well developed countries. In a study, chemical synthetic inhibitors of "glucosidase" and "pancreatic amylase" can be effectively used to treat hyperglycemia and finger millet seed coat phenolic extracts were found to be effective inhibitors of these enzymes. (Shobana *et al*., 2009).Food formulations and preparations based on finger millet have a lower glycemic index and cause a lower glycemic response (Kumar *et al*., 2016). Certain anti-nutritional factors found in whole finger millet fractions (such as tannins, phenolics, and phytates) may help to reduce glycemic response by reducing starch digestibility and absorption. Independent rat studies have successfully demonstrated that a finger millet diet fastens the wound healing process and delays cataractogenesis (Shobana *et al*., 2010).

1.6.3 Cardio-protective and Anti-hyperlipidemic properties

Cardiac diseases are one of the most severe problems suffered by people worldwide. Risk factors such as high blood pressure, high cholesterol, hypertension, depression, obesity, and diabetes are associated with the problem (Kumar *et al*., 2016). Finger millet rich diet lowers lipid per oxidation reaction, which reduces the risk of arteriosclerosis and thus provides important protection against strokes and heart attacks. A similar recent study has found that a multigrain formulated diet containing finger millet was effective in controlling lipid and antioxidant metabolism in high cholesterol intake rat models. (Vasant *et al*., 2014).

1.6.4 Prevention of GIT Disorders

Celiac disease (caused by consumption of gluten protein) is one of the most common auto-immune genetic disorders that affect people worldwide. The treatment includes consumption of flour that is free from gluten protein and similar protein structure and non-glutinous nature can be found in finger millet instead of wheat. Chandrasekara and Shahidi, 2012).Finger millet is high in soluble and insoluble dietary fibers, which are resistant to digestion and help in prevention of gastrointestinal problems, colon cancer, cardiovascular diseases and diabetes. Polyphenols, present in outer skin, can help to reduce peptic inflammation and ulcers too (Kumar *et al*., 2016). Consumption of food products made from finger millet can increase the satiety level, lower calorie intake, and aids weight loss.

1.6.5 Prevention of Osteoporosis bone defects

Osteoporosis is a "silent" disease that causes bone loss and is related with porous bones. The prevention of bone diseases such as osteoporosis is aided by a high dietary intake of naturally available calcium. Finger millet is a good source of calcium, with the seeds containing up to 350 to 400 mg/100 g of calcium, which is nearly 5–10 times more than other cereals.(Sanwalka *et al*., 2011; Kumar *et al*., 2013).Concluding, finger millet-derived products can be used to promote bone mass development in growing children as well as to prevent osteoporosis and other bone diseases in adults and the elderly (Kumar *et al*., 2016).

II. APPLICATION IN FOOD INDUSTRIES:

By going through, a number of health benefits can be figured out and a number of value added products can be made out of Finger millet (*Eleusine coracana*) which can further prove to be effective for growth, development and repair of children as well as adults irrespective of age, sex and gender. Flour of finger millet can be used for the preparation nutria dense recipes for toddlers as well as adults. Finger millet flour provide many health benefits like finger millet for losing weight, bone health, lowering blood cholesterol and treating anemia. Products available in market are multi-grain noodles, millet rich drinks, Ragi cookies and biscuits, vermicelli, etc (Kakri *et al*., 2020)

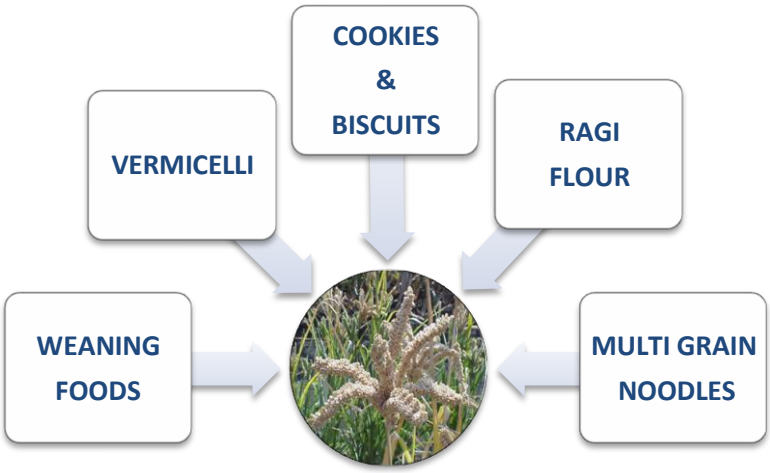


FIGURE 4: Application of finger millet in food industries

III. CONCLUSION AND FUTURE PROSPECTS

Finger millet (*Eleusine coracana*) or *Ragi* or *mandua* in belongs to grass family Gramineae or Poaceae. Finger millet is rich in several phytochemicals as well as nutrients which serves advantageous for it to be utilized in food industries as supplements. Apart from food applications, its bioactive compounds (Tannins, steroids, polyphenols, alkaloids, terpenoids, cardiac glycosides, balsams, lignans, phytooestrogens, phytocyanins. Gallic acid, ferulic acid, quercetin, vanillic acid, caffeic acid, sinapic acid, quercetin and proanthocyanidins) can be extracted for medicinal purposes. More and more research is needed for proper utilization and value addition of cereal crop.

REFERENCES

[1] Karki, A., Chandra, A., Joshi, S., Rawat, S., and Sharma, S. (2020). An overview of Finger millet (*Eleusine coracana L.*). *J Pharmacogn Phytochem*;9(4):866-869.

[2] Antony Ceasar, S., Maharajan, T., Ajeesh Krishna, T. P., Ramakrishnan, M., Victor Roch, G., Satish, L., & Ignacimuthu, S. (2018). Finger Millet [*Eleusine coracana (L.) Gaertn*.] Improvement: Current Status and Future Interventions of Whole Genome Sequence. Frontiers in *Plant Science*, 9. doi:10.3389/fpls.2018.01054

[3] Chandra, D., Chandra, S., Pallavi, & Sharma, A. K. (2016). Review of Finger millet *(Eleusine coracana (L.) Gaertn)*: A power house of health benefiting nutrients. *Food Science and Human Wellness*, 5(3), 149–155. doi:10.1016/j.fshw.2016.05.004

[4] Chandrasekara, A., and Shahidi, F. (2012). Bioaccessibility and antioxidant potential of millet grain phenolics as affected by simulated in vitro digestion and microbial fermentation. *J. Funct. Foods* 4, 226–237. doi: 10.1016/j.jff.2011.11.001.

[5] Chethan, S., and Malleshi, N. G. (2007). Finger millet polyphenols optimization of extraction and the effect of pH on their stability. *Food Chemistry* 105, 862–870. doi: 10.1016/j.foodchem.2007.02.012

[6] Devi, P. B., Vijayabharathi, R., Sathyabama, S., Malleshi, N. G., & Priyadarisini, V. B. (2011). Health benefits of finger millet (*Eleusine coracana L.*) polyphenols and dietary fiber: a review. *Journal of Food Science and Technology*, 51(6), 1021–1040. doi:10.1007/s13197-011-0584-9 downloaded on 2020-08-08

[7] Gull, A., Jan, R., Nayik, G.A., Prasad, K., Kumar, P., & Longowal, S. (2014). Significance of Finger Millet in Nutrition, Health and Value added Products: A Review.

[8] Kumar, A., Goel, B. K., Karthikeyan, S., Asgar, S., Gedda, A. K., Choudhary, K. K., *et al*. (2013). Protein and calcium rich malted health drink power. *J. Food Process. Technol.* 4, 214. doi: 10.4172/2157-7110.1000214.

[9] Kumar, A., Metwal, M., Kaur, S., Gupta, A. K., Puranik, S., Singh, S., Yadav, R. (2016). Nutraceutical Value of Finger Millet [*Eleusine coracana (L.) Gaertn.*], and Their Improvement Using Omics Approaches. *Frontiers in Plant Science*, 7. doi:10.3389/fpls.2016.00934

[10] Maharajan T, Antony Ceasar S, Ajeesh Krishna TP and Ignacimuthu S (2021) Finger Millet [*Eleusine coracana (L.) Gaertn*]: An Orphan Crop With a Potential to Alleviate the Calcium Deficiency in the Semi-arid Tropics of Asia and Africa. Front. Sustain. *Food Syst.* 5:684447. doi: 10.3389/fsufs.2021.684447

[11] Murtaza, N., Baboota, R. K., Jagtap, S., Singh, D. P., Khare, P., Sarma, S. M., *et al*. (2014). Finger millet bran supplementation alleviates obesity-induced oxidative stress, inflammation and gut microbial derangements in high-fat diet-fed mice. *Br. J. Nutr.* 112, 1447–1458. doi: 10.1017/S0007114514002396.

[12] Muthamilarasan, M., Dhaka, A., Yadav, R., & Prasad, M. (2016). Exploration of millet models for developing nutrients rich graminaceous crops. *Plant Science*, 242, 89-97. http://dx.doi. org/10.1016/j.plantsci.2015.08.023. PMid:26566827.

[13] Patel, S., Naik, R. K., Sahu, R., & Nag, S. K. (2014). Entrepreneurship development through finger millet processing for better livelihood in production catchment. *American International Journal of Research in Humanities, Arts and Social Sciences*, 8(2), 223-227. Retrieved from http://iasir.net/AIJRHASSpapers/AIJRHASS14-711.pdf

[14] Ramashia, S. E., Anyasi, T. A., Gawata, E. T., Meddows-Taylor, S., and Jideani, A. I. O. (2019). Processing, nutritional composition and health benefits of finger millet in sub-saharan Africa. *Food Science and Technology*. doi:10.1590/fst.25017

[15] Sanwalka, N. J., Khadilkar, A. V., and Chiplonkar, S. A. (2011). Development of non-dairy, calcium-rich vegetarian food products to improve calcium intake in vegetarian youth. *Curr. Sci.* 101, 657–663.

[16] Shobana, S., Harsha, M. R., Platel, K., Srinivasan, K., and Malleshi, N. G. (2010). Amelioration of hyperglycaemia and its associated complications by finger millet (*Eleusine coracana* L.) seed coat matter in streptozotocin-induced diabetic rats. *Br. J. Nutr.* 104, 1787–1795. doi: 10.1017/S0007114510002977.

[17] Shobana, S., Krishnaswamy, K., Sudha, V., Malleshi, N. G., Anjana, R. M., Palaniappan, L., & Mohan, V. (2013). Finger Millet (Ragi, *Eleusine coracana L.). Advances in Food and Nutrition Research,* 1–39. doi:10.1016/b978-0-12-410540-9.00001-6

[18] Shobana, S., Sreerama, Y. N., and Malleshi, N. G. (2009). Composition and enzyme inhibitory properties of finger millet (*Eleusine coracana* L.) seed coat phenolics: mode of inhibition of a-glucosidase and pancreatic amylase. *Food Chem.* 115, 1268–1273. doi: 10.1016/j.foodchem.2009.01.042.

[19] Singh, p. (2012). Finger millet for food and nutritional security. *African Journal of Food Science*, 6(4). doi:10.5897/ajfsx10.010

[20] Thapliyal, V., & Singh, K. (2015). Finger millet: potential millet for food security and power house of nutrients. *International or Research in Agriculture and Forestry*, 2(2), 22-33. Retrieved from http://www.ijraf.org/pdf/v2-i2/4.pdf

[21] 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. Retrieved from https://org/PDF%2015%20-%201/15-21%20(2953).pdf

[22] USDA National Nutrient Database for Standard Reference, Release 28 (2016). US Department of Agriculture, Agricultural Research Service, Nutrient Data Laboratory. Available at:

https://ndb.nal.usda.gov/ndb/foods?fgcd=&manu=&lfacet=&count=&max=&sort=&qlookup1074=&offset=&format=Abridged&new=&measureby=

[23] Vasant, R. A., Patel, N. D., Karn, S. S., and Narasimhacharya, A. V. R. L. (2014). Physiological role of a multigrain diet in metabolic regulations of lipid and antioxidant profiles in hypercholesteremic rats-Multigrain diet in hyperlipemia. *J. Pharmacopuncture* 17, 34–40. doi: 10.3831/KPI.2014.17.014