

A REVIEW

A review of the nutritional properties of ragi (*Eleusine coracana* L.)

■ Babita Yadav

SUMMARY

Ragi, also known as *Eleusine coracana* according to its scientific name, is a type of cereal grown annually and mostly produced in tropical areas of Asia and Africa, such as Ethiopia, Sri Lanka and India. The nutritional and physiological benefits of Ragi, as well as its application in meals with added value, are investigated in this article. Ragi, also known as Mandau, is a kind of millet that is extensively cultivated in a number of places across India and Africa. It has the same amount of protein as rice (around 6–8%) and about the same amount of fat (about 1-2%), but it has a higher concentration of minerals and micronutrients than rice and wheat. In terms of its nutritional value, it has a high concentration of calcium (344 mg per 100 g), dietary fiber (15–20%), and phenolic compounds (0.3–3%). These essential amino acids, such as isoleucine, leucine, methionine, and phenyl alanine, can only be found in very little starchy foods. It is also known to provide a number of health advantages, such as antitumorigenic, anti-diabetic, and atherosclerogenic properties, which are mostly related to the fact that it contains dietary fiber and polyphenols. Due to the fact that it is a native short millet, it is utilized in the creating variety of culinary products in its usual and malted forms. The grains of this millet are crushed into flour, which may then be used to produce a wide range of foods and snacks. These foods and snacks include various puddings, pancakes, cookies, roti, bread, noodles, and other products that are quite similar to each other. In addition to this, it may be malted and then used as a meal that is healthy for newborns. Additionally, it is regarded to be a nourishing diet for persons who have diabetes. Ragi is loaded with a wide variety of nutrients, making it an excellent food choice for improving digestion, lowering the risk of cardiovascular disease, preventing premature ageing, and lowering diabetes.

Key Words : Finger millet, Ragi, Health benefits, Nutrition, Diabetics, Health foods, Nourishing food, *Eleusine coracana* L.

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India, throughout the world, cultivates finger millet (*Eleusine coracana* L.), sometimes known as ragi or mandua. Ragi (*Eleusine coracana*), is called

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finger millet because its grain head has five spikes, representing five fingers on the palm of the hand. Gramineae perennial grass reaches 1–2 m tall. Narrow, green, 30–70 centimetre leaves. Brown, crimson, or purple flowers on straight or curving stems store seeds (Vettriventhan *et al.*, 2020). Its native names in numerous Indian states include “Ragi” in Kannada, Hindi and

Telugu, “Nachni” in Marathi, “Madua” in Bengali and “Kezhvaragu” in Tamil. India produces 60% of worldwide finger millet. Finger millet is eaten unhulled. It develops in 100-130 days and thrives in acid soils and increased rainfall (600-1,200 mm). Its capacity to adapt to varied agro-climatic conditions makes it the most productive millet. Karnataka, Tamil Nadu, Andhra Pradesh and areas of North India cultivate it. Finger millet is an excellent source of protein, lipids, and minerals and is crucial in adaptation regions, although it is not traded internationally (Chowdhary *et al.*, 2020). Those living in poverty in South-East Asia and East Africa are dependent on this rather unimportant comparison to barley, rice, maize and wheat. A little is a minor grain that has small seeds (1.2–1.8 mm in diameter) and a seed coat that ranges in colour from light brown to brick red. It is also rich in phytochemicals such as dietary fibre and polyphenols (Yadav *et al.*, 2022). The world’s fourth most

widely grown millet alongside sorghum, pearl millet, and foxtail millet are finger millet. Uganda, Kenya, and India and Nepal are the biggest producers. It grows rainfed and at higher elevations. Karnataka, Uttarakhand, Jharkhand and Maharashtra, Tamil Nadu, Andhra Pradesh, Orissa produce the most finger millet. Finger millet has 65–75% carbohydrates, 8% protein, 15–20% fibre and 2.5–3.5% minerals. Native minor millet is used in natural and malted geriatric, infant and nutrition products. This millet is used to make porridge, puddings, pancakes, cookies, roti, bread, and other snacks. It’s nourishing for diabetics and infants when malted (Amadou *et al.*, 2013).

Ragi nutritional value :

Singh *et al.* (2022) studied that Ragi (*Eleusine coracana*), has an outstanding nutritional profile, containing all of the major macronutrients- carbohydrates,

Table 1: Nutrition composition of ragi millets, rice, and Wheat (per 100 g edible portion, 12% moisture content)

Sr. No.	Particulars	Finger millet	Maize	Wheat
1.	Carbohydrates (g)	72.6	73	71.0
2.	Protein (g)	7.7	9.2	11.6
3.	Crude fibre (g)	3.6	2.8	2.0
4.	Fat (g)	1.5	4.6	2.0
5.	Ash (g)	2.6	1.2	1.6
6.	Calcium (mg)	350	26	41
7.	Riboflavin (mg)	0.19	0.20	0.10
8.	Thiamine (mg)	0.42	0.38	0.41
9.	Iron (mg)	3.9	2.7	3.5
10.	Niacin (mg)	1.1	3.6	5.1

Table 2 : Profiles of different grain varieties of millet in the reference of amino acids

Foxtail millet (defatted flour) (a)	Proso millet (dehulled grain) (b,c)	Pearl millet (true prolamine) (c)	Finger millet (native grain) (d)
4.59	4.1	5.1	4.3
13.60	12.2	14.1	10.8
1.59	1.5	0.5	2.2
3.06	2.2	1.0	2.9
6.27	5.5	7.6	6.0
3.68	3.0	3.3	4.3
5.81	5.4	4.2	6.3
9.30	10.9	8.1	6.1
7.71	6.2	6.2	5.7
3.00	3.2	0.9	3.4
2.91	2.1	0.7	3.3
0.45	NA	0.8	NA
22.00	21.3	22.8	23.2

fats, and proteins and fibres, - as well as significant quantities of vital micronutrients - vitamins and minerals. It has low amounts of cholesterol and salt, which promotes heart health. Furthermore, ragi includes significant amounts of vitamins B complex, C and E, which helps to improve immunological, skin, and hair health. Ragi flour has significant concentrations of the B complex vitamins thiamine, riboflavin, niacin, and folic acid, as well as magnesium, iron, and phosphorus, calcium fully confirming its reputation as a healthful breakfast cereal and a superfood (Bello *et al.*, 2022).

Ragi in reality is a positive fiber-rich Indian cuisine, which may be substituted for rice, wheat, or barley in the Indian diet. It has the distinction of being a relatively rare plant source of important amino acids such as isoleucine, tryptophan, valine, methionine, and threonine, therefore complementing other sources.

The holistic dish that is ragi and its many health benefits:

Ragi is an amazing resource of several essential nutrients, including vitamin C, vitamin E, the B-complex vitamins, iron, calcium, anti-oxidants, protein, fibre, an appropriate quantity of calories, and healthful unsaturated fats. After a good night's sleep, the levels of metabolic activity in the intestines and the stomach are at their highest first thing in the morning. This is true even if you didn't get much sleep the night before. Therefore, having breakfast items made with ragi such as ragi upma or ragi paratha stimulates the digestive fluids and ensures that all of the nutrients included in ragi are absorbed completely. These nutrients are absorbed into the circulation, where they are then transported to important organs in the body, such as the liver, heart, lungs, and brain. In addition, ragi includes fibre, which has a role in maintaining the normal movement of digestive fluids throughout the digestive system (Bello *et al.*, 2022).

Provides crucial amino acids :

Singh *et al.* (2022) concluded that Ragi is among the few plant-based sources of high-quality protein since it only contains a small number of essential amino acids. In addition to this, it supplies the amino acid methionine, which is based on sulphur, as well as the amino acids valine and isoleucine, which help to repair damaged muscle tissue. Finally, it supplies the amino acid threonine, which helps regenerate healthy enables the correct formation of teeth and enamel, and helps el and helps to keep the mouth clean. Gum disease is something that

can be avoided.

Promotes a diet that is free of gluten:

Millet is a type of grain that does not naturally contain gluten and may either be consumed as a whole seed (for example, in place of rice) or ground into flour and used in cooking and baking. It is a grain crop that has been farmed in India and Africa for hundreds of years, but it has only just started to gain popularity in the United States.

Improves skeletal health:

Ragi is regarded one of the greatest non-dairy sources of calcium when compared to other millet grains, with 344 milligrams of the mineral in 100 grams of ragi. [2]. Calcium is a necessary element for maintaining the health and strength of your bones and teeth, therefore preventing the onset of osteoporosis in adults. Ragi porridge is popular among growing youngsters because of its high calcium content.

Control diabetes :

The millet seed coat (testa) has a high concentration of polyphenols and dietary fibre. Ragi is used to treat type 2 diabetes, a chronic metabolic condition characterised by hyperglycemia caused by inadequate insulin production. It helps to keep your blood sugar levels constant since it has a low glycemic index. As a result, diabetics who use ragi in their regular diet have a low glycemic reaction (Bello *et al.*, 2022).

Helps to promote weight loss:

Ragi's high dietary fibre content saves you from overeating and keeps your stomach fuller for longer. It also includes the amino acid tryptophan, which acts as an appetite suppressant and aids in weight loss. To avoid obesity, use wheat and rice with ragi (Bello *et al.*, 2022).

Improves cardiovascular health :

Ragi flour has a high magnesium and potassium content. Magnesium promotes normal pulse and nerve function, whereas potassium promotes appropriate heart muscle activity and decreases the risk of atherosclerosis. On the other hand, the fibre content and the amino acid threonine help to prevent fat formation in the liver and reduce total cholesterol levels (Singh *et al.*, 2022).

Provides energy:

Ragi contains carbs, protein, and unsaturated fat,

which will help feed your body and brain. Ragi may be consumed as a pre/post workout snack, or if you are feeling tired, a bowl of ragi can quickly boost your energy levels. It also boosts your physical performance and helps you gain endurance. Ragi's tryptophan content is also known to assist the body relax naturally, lowering anxiety, headaches, and depression.

Protects prevent chronic diseases :

Ragi's polyphenol antioxidants aid in the body's defence against chronic illnesses and infections [8]. Antioxidants shield healthy cells from the oxidative damage produced by free radicals. These free radicals are known to cause and modify lipids, proteins, and DNA, resulting in a variety of disorders such as cancer and heart disease (Singh *et al.*, 2022).

Combats anaemia:

Ragi is a good source of iron and is recommended for anaemic patients and people with low haemoglobin levels. Hemoglobin is a protein found in red blood cells that transports oxygen throughout the body. Furthermore, this millet contains thiamine, which aids in the synthesis of red blood cells constipation (Abioye *et al.*, 2022).

Beneficial for breastfeeding mothers:

Breastfeeding women who take ragi as part of their daily diet will produce more breast milk. It increases milk production owing to the inclusion of amino acids, calcium, and iron, all of which are good to the infant constipation (Poornakala, 2022 and Ojha *et al.*, 2022).

Improves digestion:

Ragi's dietary fibre level aids in appropriate meal digestion. It facilitates the passage of food through the gut, making it simpler to digest. Fiber also promotes smooth bowel movements and helps to avoid constipation and irregular stools (Singh *et al.*, 2022).

Provides anti-aging benefits:

The seed coat of ragi grains has a high concentration of phenolic acids as well as flavonoids. Phenolic acids and flavonoids are two types of antioxidants that effectively eliminate free radicals and have anti-aging abilities. It stimulates the formation of new skin cells, which in turn helps to cover the appearance of wrinkles and fine lines. In addition, the large stocks of amino acids that ragi has contribute to the creation of collagen, which helps to maintain the pliability and smoothness of the

skin constipation (Abioye *et al.*, 2022, Poornakala, 2022 and Ojha *et al.*, 2022).

Hyperpigmentation heals:

The very high levels of amino acids and powerful antioxidants that it contains are the primary reasons behind this. In addition, ragi flour has a little grainy consistency, which makes it a great exfoliator. Not only does it completely remove dead skin cells from the face, body, and scalp, but it also gives the skin and hair a revitalized look and a gorgeous luster. As a result of the skin-tightening, protecting, and rejuvenating properties of ragi, making a herbal mask out of ragi and combining it with some milk and honey or another natural mixture is an excellent method for removing suntan, repairing damage caused by ultraviolet rays, and evening out skin tone constipation (Abioye *et al.*, 2022).

Reduces boils and acne:

Ragi contains tannins, which are plant chemicals having anti-inflammatory properties. As a result, it assists in the reduction of acne, pimples, and boils, as well as the removal of dark spots and scars constipation (Abioye *et al.*, 2022 and Ojha *et al.*, 2022).

Prevents hair loss:

In addition to include ragi in one's diet, applying a ragi hair mask to one's tresses, which includes formative amino acids like methionine and lysine, enhances the growth of hair and revitalises the hair's texture. This helps to prevent premature greying and balding as well as lowers the amount of hair that is lost constipation (Abioye *et al.*, 2022, Poornakala, 2022 and Ojha *et al.*, 2022).

Remedy to prevent dandruff :

Ragi, when made into a herbal paste and applied to a scalp that is prone to dandruff, has a multitude of vital amino acids and carotenoids that encourage hair production and have anti-microbial effects. In addition to relieving itching, this calms the follicles or roots of the hair, so restoring health to a damaged scalp and improving the condition of dry, brittle hair constipation (Ojha *et al.*, 2022).

Natural treatments for liver disorders:

Ragi has a high concentration of antioxidants, which play an important role in the speedy elimination of harmful free radicals from the body, notably in the liver and

gallbladder. By doing so, a harmony is established between the three physical doshic phases, all unwanted fatty accumulations are flushed out of the body, and the liver is given the opportunity to perform at its highest level of efficiency (Singh *et al.*, 2022).

Reduces depression symptoms:

Ragi, which possesses neurotransmitter modifying properties, efficiently promotes the pleasurable state of mind known as sattva while reducing the condition known as tamas, which is characterised by lethargy. This does wonders for boosting one's mood, improving one's cognitive abilities and helping the brain recover from the effects of depression constipation (Abioye *et al.*, 2022 and Ojha *et al.*, 2022).

Finger millet value added products:

It may be used in a variety of ways and is a fantastic alternative for other cereals such as rice and other starchy cereals. Below are some examples of value-added goods and ways to use this small millet as a base material. These items are either in use or have been shown to increase consumption of this specific millet.

Chapati (Roti):

Wheat and ragi in a 7:3 (wheat: ragi) ratio are acceptable for manufacturing Chapati (Roti). Although the gluten level is lowered in this proposed blend, the flatness of chapati is not impacted. In addition, the chapati's colour darkens somewhat. Ragi fortification in chapati not only improves the taste but also effectively lowers the glucose level in diabetic patients. The slow digestion rate and high fibre content make us feel full on fewer calories, which can help reduce overeating. Aside from that, the fibre in ragi is beneficial to persons who suffer from constipation (Abioye *et al.*, 2022, Poornakala, 2022 and Ojha *et al.*, 2022).

Papad :

Ragi flour is used as the basic material in papad, along with other important components such as black or green gram, rice, and spices. The flour is first cooked in water until it forms gelatin and the dough is ready. This dough is produced in thin sheets, rolled and cut into desired form and size, and then dried to the required moisture content of 7-8%. (DB). It does, however, produce the papad a little deeper colour since the pericarb is not separated from the starch, which when re-fried or roasted turns lighter with high customer acceptance

(Poornakala, 2022).

Puffing or popping:

One of the most common traditional techniques of preparing millets is puffing or popping. Popped millet and its flour are RTE products that have a lovely texture and unusual flavour. By neutralising some anti-nutritional elements and boosting protein and carbohydrate digestibility, this procedure boosts nutritional value constipation (Abioye *et al.*, 2022 and Poornakala, 2022). The technique also improves the raw material's appearance, colour, flavour and scent. Depending on flavour and choice, the flour may be used to produce a range of RTE meals. Whole ragi grains are conditioned for swelling by adding extra water to attain 18-20% moisture content and tempering under shed for 4-6 hours. Following the HTST (high temperature and short time) method, the conditioned grain is stirred and blown on a surface of hot sand maintained at around 230-250 C for a brief period. During this process, the sugars in the aleurone layer mix with the amino acids in the millet, resulting in the Maillard reaction and the development of a pleasant and highly sought scent. Furthermore, during this process, the grain's vapour pressure rises and the moisture in the grain is transformed to steam; the starch gelatinizes and bursts constipation (Abioye *et al.*, 2022, Poornakala, 2022 and Ojha *et al.*, 2022). Because the grain is dried to a very low degree during this procedure, it may be used to make biscuits, ragi vermicelli, and other products. In terms of mineral and micronutrient richness, it is equivalent to, if not superior than, many cereals. Its primary usage as a food is limited to the location where it is grown and customary preparation. This millet has the ability to offer customers with nutritional security (Singh *et al.*, 2022). Its consumption in cities can be enhanced with the improvement of post-harvest processing and value addition technology.

Side effects of ragi:

In general, most healthy people, including those who are overweight or have specific lifestyle problems such as diabetes, tolerate ragi use on a daily basis. Ragi, on the other hand, is high in calcium and should be avoided or limited by persons with renal problems. This, in turn, can raise the quantity of oxalic acid in the body, leading to more urine or kidney stones (Devi *et al.*, 2014).

Conclusion:

Everyone of any age can benefit from ingesting

millet because it is a grain crop that is high in nutrients. Because it is free of 6 and contains all of the essential components, including dietary fibre, protein, iron, calcium, antioxidants, and vitamins, it is a true superfood. Additionally, because it is gluten-free, it is suitable for individuals who have sensitivities to particular grains and gluten. Have allergies. However, similar to the consumption of any other type of food, ragi should be kept to a minimum in order to prevent any adverse effects on the body. When ingested in the appropriate levels, ragi or ragi has the potential to help protect against malnutrition as well as degenerative illnesses like as osteoporosis, arthritis, and Alzheimer's disease. Incorporate this highly nutritious crop into traditional Indian meals like roti, dosa, and halwa by using sprouted seeds or ragi flour. It offers tremendous advantages for both the physical and mental well-being.

Conflicts of interest:

The authors declare no conflict of interest.

REFERENCES

- Abioye, V. F., Babarinde, G. O., Ogunlakin, G. O., Adejuyitan, J. A., Olatunde, S. J. and Abioye, A.O. (2022). Varietal and processing influence on nutritional and phytochemical properties of finger millet: A review. *Heliyon*, e12310.
- Amadou, I., Gounga, M.E. and Le, G.W. (2013). Millets: Nutritional composition, some health benefits and processing-A review. *Emirates J. Food & Agric.*, 501-508.
- Bello, O. M., Ogbesejana, A. B., Balkisu, A., Osibemhe, M., Musa, B. and Oguntoye, S.O. (2022). Polyphenolic fractions from three millet types (Fonio, Finger millet, and Pearl millet): Their characterization and biological importance. *Clinical Complementary Medicine & Pharmacology*, 2 (1) : 100020.
- Chowdary, D. M. and Bisarya, D. (2020). Review of finger millet (*Eleusine coracana* L.) on nutrition and health benefits. *Adv. Food Nutr. Res.*, 8 (110) : 1319-1323.
- Devi, P. B., Vijayabharathi, R., Sathyabama, S., Malleshi, N. G. and Priyadarisini, V. B. (2014). Health benefits of finger millet (*Eleusine coracana* L.) polyphenols and dietary fiber: a review. *J. Food Sci. & Technol.*, 51 : 1021-1040.
- Gull, A., Jan, R., Nayik, G. M., Prasad, K. and Kumar, P. (2014). Significance of finger millet in nutrition, health and value added products: A Review. *J. Environmental Science, Computer Science & Engineering & Technology*, 3 (3) : 1601-1608.
- Maharajan, T., Ceasar, S. A. and Ajeesh Krishna, T. P. (2022). Finger millet [*Eleusine coracana* (L.) Gaertn]: Nutritional importance and nutrient transporters. *Critical Reviews in Plant Sciences*, 41(1) : 1-31.
- Ojha, S. N., Anand, A., Sundriyal, R.C. and Arya, D. (2022). Traditional dietary knowledge of a marginal hill community in the Central Himalaya: Implications for food, nutrition and medicinal security. *Frontiers in Pharmacology*, 12 : 3951.
- Onipe, O. O. and Ramashia, S.E. (2022). Finger millet seed coat-A functional nutrient-rich cereal by-product. *Molecules*, 27 (22) : 7837.
- Poornakala, S. J. (2022). Utilization of finger millet in food preparations: a mini review. *J. Postharvest Technology*, 10 (3) : 150-153.
- Singh, V., Lee, G., Son, H., Amani, S., Baunthiyal, M. and Shin, J. H. (2022). Anti-diabetic prospects of dietary bioactives of millets and the significance of the gut microbiota: A case of finger millet. *Frontiers in Nutrition*, 9.
- Vetriventhan, M., Azevedo, V. C., Upadhyaya, H. D., Nirmalakumari, A., Kane-Potaka, J., Anitha, S. and Tonapi, V.A. (2020). Genetic and genomic resources, and breeding for accelerating improvement of small millets: current status and future interventions. *The Nucleus*, 63 : 217-239.
- Yadav, L. and Maurya, N. K. (2022). Fight hidden hunger through national programmes and food based approaches. In : F. Saeed, A. Ahmed and M. M. Afzaal (Eds.), *Malnutrition Intech Open*. <https://doi.org/10.5772/intechopen.104459>.

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