REVIEW ARTICLE

# Ragi Traditional But Nutritional Especially in the Era of COVID-19

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## ABSTRACT

Finger millet is the name commonly used to denote the crop *Eleusine coracana*. It is known as Ragi in many parts of India, which is an important member of the family of cereals. In fact, it is superior to many cereals like wheat and rice in terms of its micronutrient content and bioavailability. Several indigenous processing techniques may be applied to finger millets allowing it to be processed into various value-added products, which may be better in appearance, taste, flavor and acceptability. Development of value-added products that contain Ragi as one of their major components can be beneficial for food and nutrition security of Indians. Ragi may contribute to solving the issue of micronutrient deficiency and nutrition security as it is an important source of micronutrients and can be easily incorporated in various recipes and value-added products. It can therefore be a part of various nutritional programs to enhance the nutritional density of foods.

**Keywords:** Finger millet, ragi, micronutrient, value-added products

The pandemic of SARS-CoV-2 (COVID-19) has had an enormous impact on India's healthcare infrastructure. It has been fierce battle fought with incredible courage and dedication by healthcare experts of the country and it is due to their conjoint efforts that the pandemic of COVID-19 was well-tackled even though the virus continued its menacing spread wave after wave.[1,2]

Thousands of doctors from every medical and surgical establishment were infected. Increasing COVID-19 infection amongst health workers revealed the need for effective control strategies, which was necessary for uninterrupted services of the health workers against the rapidly spreading outbreak.

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The pandemic's expansion did not lead to the exhaustion of healthcare institutions rather, it exposed existing flaws in healthcare systems around the world. "The Dead teaches the living", as the saying goes, and it was only after the brave sacrifices of several health workers who died treating the sick, the government and health systems realized that health workers are the most valuable resource in this pandemic and began taking appropriate measures to protect them.[3]

Drugs such as hydroxychloroquine, remdesivir, favipiravir, ivermectin and others have been used to prevent and treat SARS-CoV-2 (COVID-19),[4-7] with ivermectin being a particularly effective weapon in the anti-COVID-19 arsenal.[8] Several trials are being conducted in India and around the world for the approval of ivermectin in the COVID-19 treatment. A group of senior doctors from India with vast experience in the management of COVID-19 got together and published a white paper to propose ivermectin, a strong antiviral drug, as a therapeutic option in the prevention and treatment of mild, moderate and severe cases of COVID-19, which adds credibility to its use in the treatment as well as prophylaxis of COVID-19 virus following which it was added in the Government order of the state of Uttar Pradesh for management and prophylaxis of COVID-19.[9,10]

Almost 70% of the population in India resides in rural areas including those living in hilly and tribal areas. This population is prone to nutritional deficiencies and

hence more vulnerable to infectious diseases like COVD-19.[11] COVID-19 showed us the realm of nutrition and how it affects the daily life of an individual, role of immunity and Indian traditions (Namaste instead of Handshake, Yoga and Pranayama and being vegan). Being a developing country, there is a large majority of population, which cannot afford a meal with average nutritional value to improve and build their immune defense. Undernutrition can also lead to progression of latent infections like tuberculosis in post-COVID patients.[12] Undernourishment increases the severity of all infectious diseases and it is this vicious cycle of deteriorating sickness and worsening malnutrition that a good nutritional intervention must break.

Tough experiences teach us valuable lessons. An important take-away from this pandemic has been the need for a healthier lifestyle through adoption of healthy habits. Many of us have tended to embrace healthy behaviors and eat foods that are rich in nutrients like vitamin C and vitamin A, etc. that have allowed us to step outside and communicate. Considering this, ragi can play a vital role in taking care of all, whether from rural or urban India.

Ragi is an ancient grain that is popular in many households. But there is much more to the millet than just its flavor and texture. During the COVID pandemic, this millet has gained popularity as an immunity-boosting food.

Millets form an important dry land crop for a large population living in rural, tribal and hilly areas. Small millets include foxtail, kodo, proso and finger millet. These millets occupy 4.5% of the cultivated area in India.[13] The straw of millets becomes the main feed of cattle.

Finger millets (*Eleusine coracana*) or ragi or madwa (the name used for finger millet in the common dialect) is a routinely eaten food by people living in rain-fed hilly areas and also by the tribals of India. Amongst the various other names given to ragi, the oldest happens to be "nrtta-kondaka", which means the dancing grain in ancient Sanskrit literature.[14]

In India, finger millet is primarily farmed in the states of Uttarakhand, Odisha, Jharkhand, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu.[15] Ragi is farmed across an area of 1.2 lakh hectares in Tamil Nadu. It is the finger millet or ragi, which has a high yield of 1909 kg/ha and provides food and nutritional security to farmers in dry regions, hilly and tribal areas.[16]

Amongst many people of India and Sri Lanka, the principal cereal food is ragi. Ragi can be ground into flour and sold to consumers who can use it in biscuits, cookies, bread, toast, rusks, cakes, muffins, chapatis, dosas or cheelas. It can be also used for making porridge, puddings and cakes. Similarly, finger millets can also be consumed in the form of ragi balls and ragi idlis.[14]

## NUTRITIVE PROPERTIES OF FINGER MILLET

Finger millet, while being a gluten-free grain with a low glycemic index and nutritional and nutraceutical benefits, is overlooked and misused.[17] It contains 66.82 g of carbohydrate, 7.16 g of protein, 11.18 g of total fiber and 1.92 g of fat per 100 g of millet.[18] It has a significantly higher overall fiber and mineral content than wheat and rice. Finger millets are also a good source of calcium, which is an important macronutrient necessary for infants, children, pregnant women, as well as the elderly who are usually deprived of this macromineral. Essential amino acids including tryptophan, threonine and isoleucine are prominent in finger millet or ragi grains.[19]

The high fiber content helps to reduce risk of diabetes mellitus and gastrointestinal tract disorders.[20] The fermented grains of ragi are a rich source of vitamin B complex (riboflavin, pantothenic acid and niacin).[21] The ragi millet plant is often utilized in preparing folk medicine for treating liver disorders, measles infection, pleuritis and pneumonia.[22]

Ragi millet is vegan and gluten-free in nature. It can therefore be used as an alternative to wheat for patients with celiac disease and gluten sensitivity. The innumerous health benefits of finger millet are by virtue of the polyphenols, phytates, tannins and fiber that are present in it. The phenolic compounds in ragi that are responsible for its antioxidant and free radical scavenging activities are ferulic acid, epicatechin and catechin. Quercetin is the flavonoid which gives ragi its antimicrobial property as it has shown hindrance in the propagation of *Escherichia coli*, *Listeria monocytogenes*, *Bacillus cereus*, *Streptococcus pyogenes* and *Staphylococcus aureus*. Ragi is anti-inflammatory in nature and helps in healing of wounds, besides maintaining blood glucose homeostasis in people with diabetes. The water-soluble fibers present in ragi help reduce serum cholesterol levels and ebb the risk of atherosclerosis.[23]

Starch, which is extracted from ragi grains, is utilized in the pharma industries for making granules used for tablets and capsule dosage formulations.[24] These ragi or finger millet grains may be utilized in preparing baked products, composite flour, certain weaning foods for

infants, beverages and also some nonbeverage products.[25] Finger millets offer a variety of health benefits, some of which include delayed nutrient absorption, increased bulk of feces, lowering of triglycerides and lipids in blood, preventing colon cancer, action as a digestive barrier, mobility of intestinal contents, prolonged transit time of feces and the ability to ferment.[26]

The grains of finger millet have a seed coat, which is dark-brown in color and is high in polyphenols in comparison with other cereals like barley, maize, rice and wheat.[20] Consuming finger millets having polyphenols and dietary fiber on a regular basis is helpful in reducing the risk of diabetes and gastrointestinal disorders.

## PROCESSING OF FINGER MILLET-BASED PRODUCTS

Methods of food processing have evolved over the last many years and can be adopted in order to create the ultimate product, which is more attractive in flavor, appearance, taste, consistency and several other factors. The food processing methods that are usually employed include milling, germination/sprouting, malting, fermentation, etc.

Each process alters the nutrient value of the final food product qualitatively and/or quantitatively. Besides the regular chapatis, ragi products may include expanded or puffed forms of ragi, ragi breakfast cereals and ragi flakes, extruded products, fermented products, sweets, ready-to-make instant mixes, pasta, bakery products like cakes, biscuits, rusks, etc., beverages, health foods and some special foods like weaning foods for infants.[14,27]

The grains of ragi millet offer many possibilities for diversified utilization and value addition in its products. Processing of finger millets will make it feasible to make a variety of food products by adopting appropriate milling, popping and other indigenous and modern technologies. Finger millet can also be utilized in various bakery products by partial supplementation of the regular wheat flour with ragi flour.

Sowbhagya and Ali[28] studied the process of making vermicelli noodles from ragi. The process involved hydration and dehydration under specific treatments, conversion to flour, addition of additives and preparation of dough under specified conditions, extrusion, further processing and drying.

The vermicelli noodles made from ragi can be given to children and also adults as a healthy option for breakfast. In Uganda, finger millet is consumed by making a porridge of a stiff consistency called 'Ugali' in their native language, which is eaten with vegetables, cowpea, groundnut, meat, chicken, etc. Ragi millet porridge can be served to lactating and expectant women and children.[29] This way finger millet will provide more micronutrients to these vulnerable groups in comparison to rice, wheat or other millets.

The possibility of using ragi malt in bread making has been studied.[30] The flour malt of this millet produced more reducing sugars in bread crumbs as compared to the regular malted wheat. This indicated that there was a decreased starch content and an increased amylase activity in ragi malt than normal wheat malt.[31]

## PROSPECTIVE VALUE-ADDED PRODUCTS FROM FINGER MILLET

### Chapatis

Wheat and finger millets can be mixed in a ratio of 7:3 to make chapatis. This will not only affect the taste and texture of the chapatis but also reduce the gluten content.[32] The chapati may be slightly darker in color. Being a low glycemic index food, finger millet chapatis can help to reduce the blood glucose in patients with diabetes. Also, adding ragi to normal wheat flour may give a feeling of fullness because of its fiber content and thus help to prevent and treat obesity and constipation.[33]

### Chakli, Cheela and Khichri

These products may be prepared by blending the millet separately with green gram (moong) and soybeans in different ratios, which are acceptable in taste. Chaklis can also be prepared with puffed chickpea, finger millet, soybean flour and milk, which is skimmed and powdered; all in the ratio of 60:25:10:05.

This will prove to have a better nutrient composition than the conventional sattu with regard to protein, calcium and lysine. Hence, this may be recommended for growing children, pregnant and lactating mothers, who need additional calcium and proteins.[19]

### Papads

Papads can be prepared with finger millets as a base material with other ingredients like black or green gram, rice and other spices. Around 15% to 20% (w/w) of finger millet can be added to make the papads. While making papads, the flour may be first cooked till it is gelatinized after which it may be kneaded into a dough and then rolled into thin sheets. The resultant papads will be darker in color as the starch is not separated from the pericarp.[20]

### Puffed and Popped Millets

This is a well-liked method of making ready-to-eat millets of pleasing texture and appealing flavor. Ragi puffs can also be made by this process. The puffing and popping process of ragi millets will enhance the nutritive value of these ready-to-eat products by inactivating some of the antinutritional factors and thereby increasing their digestibility.[34]

### Noodles and Vermicelli

The changing taste of children has brought about an increase in consumption of noodles in India and abroad.

Noodles can be prepared by using different proportions of whole or refined wheat flour, malted finger millet and/or soy flour.[35]

## MALTING AND WEANING FOODS

The malt of ragi millet and milk-based beverage formulations can prove to be a well-liked beverage in India.

The favorable effects of malting in ragi are reflected by increased bioavailability of essential nutrients, lowering of antinutrient concentration and in improvising the texture, which was successfully exploited in developing malt-based human health foods.[36] Finger millets possess an appreciable malting quality. Although Tamil Nadu and Karnataka use this popular malting technique, it still has to reach the other states.

The health benefits of malting are because of the increase in the nutrients, fiber, fat, vitamin B, vitamin C and their availability.[36] Malted ragi millet, green gram and Bengal gram can be mixed together to formulate a malted weaning food for infants which is high in protein and calcium.[32]

Millet malts or ragi malts can be used as a base cereal for low dietary volume and caloric dense foods that can be utilized during the infant's weaning period, as a food supplement, in health boosting foods and as an amylase-rich food. Malting decreases the viscosity of flour paste more than several other heat treatments.[37] Malting finger millet greatly reduces tannin (brown millet) and phytic acid levels while significantly increasing ionizable iron and soluble zinc.[38] These malts can be simply eaten as a supplement by the elderly, who frequently have eating and digestive issues.

Innovative uses of finger millet may include its use in muffins, cake, cookies, laddoos, snack mix and various other snacks. It can be included in various feeding programs designed for vulnerable population, thus becoming a source of various micronutrients from a single item, which perhaps is its uniqueness in terms of its nutrient density as a millet.

## CONCLUSION

Finger millet or ragi has a good potential to provide nutritional security to people as it is a rich source of micronutrients and certain minerals like calcium and iron. This millet is majorly consumed in and around areas where it is cultivated. Increasing the knowledge regarding the potential benefits of ragi will help overcome nutritional deficiencies and also many noncommunicable diseases.

The COVID-19 pandemic has increased the nutritional crisis in India. The undernourished have become more undernourished in the rural areas whereas in the urban areas, there has been an opposite effect on the health status of people as a consequence of lockdown cooking, lack of exercise and long hours of sitting. Supplementation of normal cereals with ragi amongst the low economic society may help in bridging the gap of undernutrition by providing the required essential nutrients. Addition of ragi-based products in the diets of urban populations can help them regulate diseases like obesity, diabetes, constipation, cardiovascular problems, etc.

The vulnerable groups as well as the elderly can also gain nutritional benefits by consuming the different varieties of products that finger millet offers.

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