

Finger millet; its processing, value added products and marketing strategies: A review

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ABSTRACT

Finger millet is rich in nutrients and minerals. It is an annual herbaceous plant widely grown in arid and semi-arid areas in Africa and Asia. It is well adapted to grow under low soil fertility, low moisture and hot environmental conditions. Finger millet has nearly 7 %protein. The ash content has been found nearly 1.7 to 4.13 %. Finger millet is the richest source of calcium and iron. Due to anti-nutrients present in finger millet, it has restrictions in food preparation and to remove these, it undergoes different processing treatments after that it can be used for food preparation. Large number of foods is prepared from processed finger millet and they are supplied. These all include large number of procedures. Therefore, this review focuses on processing, value addition and different marketing strategies for its promotion.

Key words: *Finger millet, Marketing strategy, Processing, Value addition*

Introduction

Finger millet (*Eleusine coracana* L.), an ancient cereal crop commonly known as ragi or African millet, holds a special place in the agricultural heritage of many regions worldwide. Its robustness in adapting to diverse agro-climatic conditions, coupled with its exceptional nutritional content, has garnered renewed attention in recent times. As global food systems face the dual challenges of ensuring food security and promoting healthier diets, finger millet has emerged as a promising candidate for sustainable agriculture and enhanced nutrition. In this context, exploring innovative processing techniques and value addition strategies for finger millet has become imperative. Finger millet is renowned for its high content of dietary fibre, essential amino acids, vitamins and minerals. However, its full potential has often been underutilized due to challenges re-

lated to processing, storage and consumption. Traditional processing methods, while preserving some of its nutritional integrity, might fall short in meeting the demands of modern lifestyles and preferences. Therefore, researchers, food technologists and agricultural experts have been collaborating to develop novel processing methods that not only retain finger millet's nutritional richness but also address practical concerns such as shelf-life extension, convenience and palatability.

This comprehensive review aims to delve into the spectrum of finger millet processing techniques and value addition approaches. It will encompass a wide array of topics, including but not limited to, milling, malting, extrusion, fermentation and incorporation into various food formulations. By critically evaluating the scientific literature and emerging trends, this review seeks to offer insights into the successes and challenges encountered in the quest to enhance the

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value proposition of finger millet.

Moreover, as the world grapples with issues such as malnutrition, climate change and sustainable agriculture, finger millet stands out as a resilient and ecologically-friendly crop. Its ability to thrive in marginal environments with minimal water and chemical inputs makes it a valuable asset in the pursuit of resilient food systems. By shedding light on the advancements in finger millet processing and value addition, this review aspires to contribute to a deeper understanding of how this ancient grain can play a transformative role in shaping the future of agriculture, nutrition and food security.

Processing of finger millets

Grains of finger millets requires processing in order to consume to exclude the non-edible portions to increase their nutritive quality and reducing antinutrients present in it. Processing methods are basically divided into two; primary and secondary processing. Primary processing includes soaking, germination, blanching, dry heat treatment and milling increases the quality making them suitable for human consumption and secondary processing includes fermentation, popping, malting etc to prepare value added products from millets.

Soaking

It is the method used to reduce antinutrients such as phytic acid, polyphenols, saponins and oxalates (Hotz and Gibson, 2007). This method is dependent on variety used during soaking. Finger millet grains are soaked in distilled water and kept for overnight at a temperature of 30 °C to 60 °C. Next day the soaked water is removed and grains are washed with clean water in order to remove foreign particles and later it is dried in hot air oven at 60 °C for 90 min before milling (Abioye *et al.*, 2022). It has found that phytic acid content was reduced from 39.47 to 24.17% by processing (Rathore *et al.*, 2019).

Germination

It is considered that germination is the effective method for reducing antinutritional factors as compared to other processing methods (Selladurai *et al.*, 2023). Germination is a low-cost operation in which grains are steeped in water for 2 to 24 hr and incubating the soaked seed for 48 hr at 30 °C (Shimray *et al.*, 2012). It was observed that germination and phytate level was in inverse relationship. As germination increases phytate level reduction also in-

creases (Abioye *et al.*, 2022). Germination also helps to increase protein, mineral and ash content due to the increased enzymatic activities. Increased enzymatic action helps in lowering antinutritional content in finger millet such as tannin, phytic acid which increases essential minerals such as iron, zinc, calcium. It was reported that calcium content was increased during germination as oxalic acid content decreased during sprouting as oxalic acid is calcium chelating agent.

Blanching

It is also soaking grains in water in 1:5 ratio at 98 °C for 30 sec. This method was found to decrease the level of phytic acid and polyphenolic contents in finger millet. It also enhances the level of calcium, iron, manganese etc. (Selladurai *et al.*, 2023).

Dry heat treatment

It is the application of heat in the range of 95-130 °C for specific period of time. It helps in altering physiochemical properties of starch or lipids while retaining their structure. This method is simple, safe and healthy (Selladurai *et al.*, 2023).

Milling

In this processing method grains of finger millets are converted to flour by using wooden or stone mortar and pestle, hammer mills, stone mills or ball mills (Patel *et al.* 2015). Milling process includes sorting, cleaning, hulling, branning etc. This method is really important as finger millet grains contains large portions of husk and bran. Nutrient content of food grain after milling is comparatively poor but bioavailability of certain nutrients improves. During milling bioavailability of iron is also increased.

Secondary treatments

Fermentation

It is the method used for food preservation. It is the oldest and most effective of processing and preserving foods. This is a metabolic process which converts complex materials into simple form with the help of microorganism. Yeast and lactobacilli are utilized in fermentation. It was reported that during fermentation inhibitors are destructed, breakdown of protein and amino nitrogen are increased (Davidek *et al.*, 1990). It also reduces antinutrient factors. During fermentation the phytates get degraded into soluble protein as a result of microbial

synthesis of proteolytic enzymes. It is also found that phytic acid is reduced and available minerals are increased. Fermentation of finger millet flour has increased iron content from 11 to 139 %.

Popping

This method is also known as puffing which is a traditional method. Appearance, colour, taste and aroma of the processed raw material are enhanced by this process. It is a high temperature short duration process. Grains are subjected to a temperature of 230-260 °C for 15-25 sec giving rise to a porous, crunchy and pre-cooked products. Popped finger millet flour is prepared by conditioning with grain with 3 to 5 % water to raise the moisture content by tempering for 2-4 hrs (Selladurai *et al.*, 2023). The product obtained is ready-to-eat snack which can be further pulverized by adding protein rich nutrients. This method also increase bio accessibility of iron in finger millet and calcium is decreased.

Malting

In India, malted finger millets are common as compared to malted sorghum and malted maize (Singh and Raghuvanshi, 2012). It is the controlled germination of grains under moist condition. It includes steeping, germination, sieving etc. This method is used to improve digestibility, sensory attributes and reduce antinutrients. By this process nutrient contents are increased by inducing hydrolytic activity (Banusha and Vasantharuba, 2013). Malting of finger millet has also increased mineral content when it is kept for 72 -96 hrs.

Roasting

This method is mostly done in household by dry frying. It helps to reduce antinutritional factors like cyanides, alkaloids, saponins etc. (Abioye *et al.*, 2022). It also helps to increase shelf life of the food. This method will not affect any composition of grains. By this process moisture, fat, proteins are observed slight changes while carbohydrate, ash and fibre contents are increased.

Value added products of finger millets

Finger millet is a versatile grain that works well in place of other grains like rice and other starchy grains. Finger millet is being used for various products useful to human life. Since ancient times, finger millet is used for instant feeding. It is used for beverages and milk products. It contains rich source of

amino acids which contain calcium and sulphur. The beverage prepared by finger millet known as "Ragi Malt", it is healthy and used as energy drink. For the creation of bakery goods including nankhatai, biscuits, bread and muffins, millet flour is frequently utilized. Using composite malt flour, which also contains finger millet, Bengal gram, and green gram, weaning meal is created. This mixture contains a lot of protein and calcium. The weaning foods were created using this procedure. For 48 hours, the composite flour was soaked in water at 25 °C room temperature; however 38 hours would suffice in the summer. The soaking grains were then mechanically or solar dried to end the germination process, keeping the temperature below 75 °C and the moisture level between 10-12%. A higher temperature may have a negative impact on the malt millet flour's ability to be milled since it may cause the grain kernels to parboil or harden. Following drying, the malted grains were either heated in a pan or uniformly toasted using standard methods at 70-80 °C, which helps provide the ideal flavour and aroma. The obtained malt was ground up to make it ready to eat (RTE) using any size-reduction equipment (Amber *et al.*, 2020)

Some products prepared are

Chapatti

Chapatti (also known as roti) can be made with a 7:3 ratio of finger millet to wheat. The ability to make pleasing chapatti is unaffected by the proposed blend's lower gluten level. Additionally, the chapatti's hue changes to a somewhat darker shade. The addition of finger millet to chapattis enhances flavour while also effectively lowering blood sugar levels in diabetic individuals. We feel fuller on fewer calories thanks to slower digestion and the bulkiness of the fibres, which may help us resist overindulging. Additionally, those who struggle with constipation can benefit from the fibre in finger millet (Gull *et al.*, 2014).

Papad

South India's traditional food is papad. Other necessary ingredients like rice, black gram, and spices were combined with finger millet flour (15-20%). According to Begum (2007), adding finger millet flour (up to 60%) is feasible and is done so in Karnataka. When making papad, finger millet flour is first boiled in water until it becomes gelatinous.

The dough is formed into a thin sheet by rolling and cutting it into the necessary shapes and sizes. These papad pieces are then dried to the desired moisture content of 7 per cent.

Bakery products

There have been attempts to make bakery goods such biscuits, nankhatais, muffins, and bread using finger millet flour, and efforts are being made to standardize the recipe and product quality. Millets will be superior in terms of fibre content and micro-nutrients when used in bakery products, and they will also create a strong opportunity for millets to enter the baking industry for a variety of value-added products. In a recent study, it was attempted to use malted finger millet flour as a supplement to increase the nutritional quality of cakes in terms of the minerals and fibre content (Desai *et al.*, 2010). The consumption of finger millet has gained attention recently, and attempts are being made to give consumers access to it in convenient ways (Singh *et al.*, 2012).

Malting and weaning foods

Traditionally, the millet malt is utilized for infant feeding purpose. Finger millet possesses good malting characteristics and its malting is popular in Karnataka and part of Tamil Nadu. Millet malt is used as a cereal base for low dietary bulk and calorie dense weaning foods, supplementary foods, health foods and also amylase rich foods. Malting reduces paste viscosity of flour than many other heat treatments (Malleshi and Desikachar, 1981).

Fermented foods

Fermented foods like Idli and Dosa are popular in many regions of India as breakfast fare and even as evening meals in the south, according to (Varma and Patel, 2013). Ragi is frequently used as a key component in many fermented food products, which not only enhances the taste but also fills the meal with fibre, calcium, and protein content due to the decrease in antinutrient content. Depending on preference and flavour, finger millet grains are also used to make fermented meals, either malted or sprouted. A composite finger millet and skimmed milk-based powder gruel is created by optimizing the bacterial cultures formulation (Mugocha *et al.*, 2000).

Noodles

The changing dietary preferences of children and adolescents have resulted in a thriving market for noodles in India and beyond. Demand for millet noodles, particularly those made from finger millet, is increasing due to the increasing recognition of its nutritional benefits. Noodle products, also known as convenience foods, are prepared through a cold extrusion system and become hard and brittle after drying. Cooking of these noodles is quick and convenient, taking only a few minutes. Various combinations of noodles are prepared, such as those made exclusively with finger millet, wheat and 1:1 ratio, and those blended with 5:4 ratio of wheat and soy flour. In the case of exclusivity millet-based noodles, pretreatment is used to facilitate extrusion and provide a smooth, fissure-free texture. Generally, wheat flour is used as an essential ingredient in the mixture, as it not only facilitates extrusion, but also provides a smooth texture.

Marketing strategies for processed products of finger millet

There is an immense market for finger millet, and it has great nutritional benefits and requires minimal maintenance. Despite the easing of obstacles, according to recent worldwide consumer research, the home remains the primary place for living, working, and purchasing goods. The individual circumstances of consumers are having an impact on attitudes, behaviour, and degrees of comfort when going out. The demand for regional, sustainable, and value brands is growing as consumers buy more carefully and economically. Particularly among new or occasional users, an ongoing spike in digital and omnichannel usage appears certain to continue.

Marketing for products made from finger millet. These includes

- Analyse the right potential consumer
- Clutch consumers demand pool
- Reshape, rethink, redefine and renew the product and demand
- Long trends can be added in marketing. These are:
 - (i) people becoming health conscious
 - (ii) health track and conscious consumption
 - (iii) growing local demand
- Sustainable choices
- Cost effective

- Limiting the food waste

We can save double money on foreign exchange by introducing the diversification of raw material for the brewing industry and local production. Its superior malting quality would also augment commercialization of finger millet (Taylor *et al.*, 2006). Studies have revealed ways underutilized and neglected crop species, like finger millet, can boost economic growth on both domestic and foreign markets (Chadha *et al.*, 2007). Millet value-adding in India nearly tripled farmer incomes while offering new job opportunities, mainly for women (Vijayalakshmi *et al.*, 2010). Urban customers will be inclined to finger millet products like noodles and biscuits with better presentation and packaging. Indeed, finger millet's use will rise among men, women, and youngsters who are increasingly preoccupied with their health and nutritional well-being thanks to marketing and presentation as a nutritious food (Shobana *et al.*, 2013). Productivity and forecasting of the area and production of the ragi crop in India has been increased recently. The area, production, and productivity time series data formed the core of the study (Veerabhadraappa, 2016). The study "Opportunities for enhancing production, utilization and marketing of ragi in Africa" discovered that there are currently opportunities for improved technology development, which may raise production, product development, value addition, marketing, and consumption of finger millet. Utilizing these chances could guarantee that finger millet, as a "novel" crop, improves food and nutrition security in Africa and all over the world (Opole, 2019).

Challenges to entrepreneurship in the marketing of processed finger millet commodities

Drive: The processing of finger millet is a risky business with a range of returns that could take several years to materialize. For a beginner, main deterrents may include the difficulty of first obtaining funding for agriculture ventures, government clearances, regulatory hurdles, etc. This is made worse by a lack of scientific expertise, weak management abilities, and restricted access to raw materials.

Knowledge: The business owner should have access to appropriate information on the nature of the enterprise and its economic and social advantages. In addition to technological and scientific information, the entrepreneur should have a grasp on financial management, human resource management, and any government regulations or policies that may

have an impact on the start-up business. In addition, networking is essential for a company's survival and for breaking into the market.

Skills: Although it may not be possible for entrepreneurs to have all the necessary skills for their specific business, they must still have a number of general competencies that are necessary for all entrepreneurs, such as self-motivation, self-confidence, work ethics, time management, administrative skills, and knowledge of sales, marketing, and finance, in addition to other abilities that are unique to their own venture.

Marketing function: Packing, logistics, and selling tasks were all part of the region's finger millet marketing process. Better packaging has historically helped to preserve quality and minimize losses due to spoiling during transit. Finger millet usually comes packed in gunny bags. The particulars of the sample farmers' marketing of finger millet, including the date of sale, the method of shipping, the market location, and the buyer.

Business development: Marketing and selling a product are difficult tasks in the current climate of competition. Finding a viable market, creating the marketing channels, and reaching the target audience are the hurdles.

Finance and risk reduction: Substantial fixed investment and working capital investments are necessary for the growth of agribusiness and agro-industries. Public sector banks are often risk cautious and seek for sufficient collateral and the entrepreneur's credit worthiness before credit. Further, the sector's risk mitigation mechanism is underdeveloped, which places farmers and agribusiness owners in a challenging situation (Christina *et al.*, 2016).

Challenges in agricultural product marketing

- Low agricultural product surplus that is marketable
- Many middlemen in a long chain
- The pricing is not set by the producer
- Scams in the marketplace
- Inadequate storage
- A lack of market knowledge

Analysis of the desired market and market research

We identified the marketing channels by which finger millet from the research area moved from the producer to the ultimate consumer.

Producer-Village Traders-Wholesalers-Consumers

Village dealers contacted farmers for harvested finger millet in fields or villages through this channel. The producer doesn't have to pay any marketing expenses for this channel. The village trader drives his goods into surrounding towns or cities' wholesale markets. The finger millet grains are sold whole by the whole vendor to the consumer (Harish *et al.*, 2015).

Product positioning: Promote ragi as a flexible and nutrient-dense grain that adheres to current dietary and health trends. Be sure to highlight its advantages, such being gluten-free, high in fibre, full of vital nutrients and acceptable for a variety of dietary needs.

Recipe showcase: Create a bunch of ragi-based dishes that are simple to make and appealing to your target market for your recipe showcase. To encourage customers to include ragi in their meals, share these recipes on your website, on social media, and in culinary lessons.

E-commerce and omnichannel: Design a user-friendly website with product information, nutritional information and a convenient online store. Implement e-commerce features so that clients may purchase ragi items. Maintain active social media accounts on websites like Facebook, Pinterest and Instagram. Share aesthetically stunning pictures, cooking tutorial videos and interesting articles on the health benefit of ragi.

Packaging and branding: Create eye-catching, educational packaging that expresses the ragi's nutritional advantages. On shop shelves, appealing packaging may draw customers' attention.

Sampling and tasting events: Arrange tasting events at community meetings, health expos, and supermarkets. Introducing ragi-based items can help conquer any initial reluctance and spark enthusiasm.

Conclusion

The ancient cereal crop finger millet is gaining popularity due to its high nutritional value and tolerance to a variety of agro-climatic situations. To preserve its nutritional content while addressing practical issues like shelf-life extension, convenience and palatability, researchers are proposing novel processing methods. Primary and secondary pro-

cessing methods for finger millet include soaking, germination, blanching and milling. Antinutrients are reduced by soaking, whereas value-added compounds are made by fermentation and malting. This review intends to further knowledge of finger millet's potential in food security, nutrition, and agriculture.

The versatile grain finger millet may be treated in a number of ways to remove antinutritional elements. An efficient technique is germination, which lowers phytate levels while raising protein, mineral and ash content. Blanching, dry heat treatment, grinding, fermentation and popping are further techniques. Due to its numerous health advantages, ragi, a wholesome and adaptable grain, has grown in popularity. Businesses may utilize educational initiatives, superfood positioning and recipe promotion to promote ragi. You may draw in new clients by focusing on health-conscious consumers, collaborating with dietitians and influencers, and running temporary specials. It might also be helpful to offer a range of recipes and interact with nearby communities. The acquisition of certificates and quality control can increase customer confidence. By utilizing user-generated material, a feeling of community may be developed around the business. Low marketable surplus, a lengthy network of middlemen, and transportation constraints are obstacles in the sale of agricultural products, too. Businesses should do in-depth market research, identify their target market, present ragi as a flexible grain, provide instructional material, display ragi-based recipes, work with partners, and more in order to promote ragi.

Conflict of Interest - None

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