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Technological, Processing and Nutritional approach of Finger Millet (*Eleusine coracana*) - A Mini Review

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Abstract

Finger millet (*Eleusine Coracana L.*) also known as African millet and is commonly called "ragi" in India. It is having excellent nutritional value and even superior to other common cereals. It is richest source of calcium (344 mg) and magnesium (408 mg) than other millets. Predominant fatty acids of this millet are Oleic (49%), linoleic (25%) and palmitic acids (25%). Finger millet contains both water-soluble and liposoluble vitamins. Emerging products prepared from this millet are pasta, noodles, vermicelli and bread. Being gluten-free it is suitable for individuals suffering from celiac disease. It is also rich source of several phytochemicals. Commonly used processing techniques for this millet are milling, malting, popping and decortications.

Keywords: Finger millet; Calcium; Magnesium; Pasta

Introduction

Finger millet (*Eleusine coracana L.*) is commonly known as "ragi" in India. The ragi word is originated from a Sanskrit word "raga" meaning red. This can be grown in almost all types of soils and climatic conditions. It is known as poor man's food because of its long sustenance as it can be stored safely for many years without infestation by insect and pests. This property makes it a very necessary famine reserve food. Commonly it is cultivated in India, Nepal, Sri Lanka, East China and Bangladesh, Kenya, Tanzania etc. *Eleusine coracana* is most common species of this millet cultivated for food use. While as *Eleusine indica* and *Eleusine africana* are wild and semi-wild species. Its grain is having distinct morphological features. It is a small seeded grain; its kernel is not having a true caryopsis but a utricle. Its pericarp (glumes) are not fused with the seed coat or testa thus its pericarp can be easily removed by rubbing or by soaking in water, sometimes it gets detached from the seed during threshing. Large differences in color, appearance and size of this millet kernel have been observed among varieties. As grain color varies from white to orange, deep brown, purple to almost red. But brick red is the most common color of its seed. Their kernel shape may be spherical, globular and oval, and varies in size from 1 mm to 1.8 mm. Its endosperm is white in color. Its seed coat contains five layers and these are attached tightly to the endosperm [1]. The endosperm is soft and fragile and is divided into three parts viz., peripheral, corneous and floury. Floury endosperm comprises about 83% of whole grain. Its endosperm is mostly filled with starch granules. The shape of starch granules may be spherical, polygonal and lenticular. Finger millet starch comprises amylose and amylopectin in the range of 25: 75.

Nutritional value of finger millet

Finger millet is having excellent nutritional value. As it contains 6% to 8% protein, 1% to 1.7% fat, starch 65% to 75%, minerals 2% to 2.25% and dietary fiber 18% to 20%. Its proximate composition is superior to wheat, maize, sorghum and rice with regard to dietary fiber, calcium and few micronutrients. The seed coat of this millet is rich source of phenolic compounds, minerals and dietary fiber [2].

Protein

Protein content of this millet ranges between 6% to 8%, although low protein content of 5% and high protein content of 12% have been reported in different varieties [3]. Prolamins content is about 35-50%, albumins and globulins constitute 8% to 15% of total proteins. Its Amino acid composition is good as it contains (2.5%) lysine, (13%) tryptophan, (2.9%) methionine, (3.1%) threonine and (4%) leucine and isoleucine.

Lipids

Lipids of this millet are mostly triglycerides and these are known to reduce the incidence of duodenal ulcer. Finger millet is having a lipid content of 1.5%. Oleic (49%), linoleic (25%) and palmitic acids (25%). are predominant fatty acids of this millet. About 72% of total lipids are present as neutral lipids, 13% as glycolipids and 6% as phospholipids [4].

Carbohydrates

Finger millet is rich source of carbohydrates (72%) and comprises (1.04%) free sugars, (65.5%) starch and non-starchy polysaccharides [5] and (11.5%) dietary fiber [6]. Wankhede et al. [7] studied the carbohydrate profile of a few varieties of finger millet and reported 59.5% to 61.2% starch, 6.2% to 7.2% pentosans, 1.4% to 1.8% cellulose and 0.04% to 0.6% lignins. The dietary fiber content of this millet is much higher (11.5%) than brown rice, polished rice and other millets such as foxtail, little, kodo and barnyard millet.

Dietary fiber

Total dietary fiber content of this millet is 22.0% which is relatively higher than other common cereal grains e.g. 12.6% wheat, 4.6% rice, 13.4% maize and 12.8% sorghum. Dietary fibers are categorized as water soluble and water insoluble. Chethan and Malleshi [8] reported 15.7% insoluble dietary fiber, 1.4% soluble dietary fiber, in finger millet grain. While as Shobana and Malleshi [9] reported 22.0% total dietary fiber, 19.7% insoluble dietary fiber and 2.5% soluble dietary fiber in finger millet.

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Vitamins

Finger millet contains both lipo-soluble and water-soluble vitamins viz., thiamin, riboflavin, niacin and apparently ascorbic acid and tocopherols [10]. Water-soluble B-vitamins of finger millet are concentrated in the aleuronic layer and germ, while as lipo-soluble vitamins are mainly located in the germ.

Post harvesting operations of finger millet

The harvesting of finger millet crop takes place mainly during October to November. There are two methods of harvesting.

Harvesting of only panicles: After crop maturity, the panicles (ear heads) of finger millet are collected by cutting with the help of sickle leaving the plant stalks as such in the field. The operation is being carried out at one time or at intervals depending on the uniformity of maturity. The harvested panicles are gathered in a container such as bamboo baskets (tokri) before heaping them in a convenient place. The panicles staked in heaps are left for sun drying for a period ranging from one week to more than a month. Because the heat generated within the heap will help in easy separation of grains during threshing.

Harvesting of stalks along with panicles: This is most commonly used method. In this method harvested stalks are spread in rows in field for sun drying for a couple of days depending on weather conditions. After sun drying the harvested stalks are bundled and staked near the threshing yard. During rainy days a stacking practice which involves arranging the bundles remaining in the field in closed lines in slanting position covered with dried straw to prevent dampening. After few days the cover is removed and allowed to dry for one to two days before staking at the yard.

Threshing of finger millet grains

Separation of grains from panicles (ear heads) is done by spreading panicles or stalk in the morning and threshing starts from 10 o'clock. Threshing of panicles or stalks is usually done by using bullocks (4-5 in number) for trampling or by stone roller drawn by a pair of bullocks. For large scale operation in some places tractors are used by farmers for grain separation. Farmers also use paddy threshers. Bamboo sticks are also used for threshing on small scale operations.

Storage

Before storage grains of finger millet are sun dried. Various types of structures (Bhakari, Kalanjiam, Semiliguda, turjhulla, Dumbriguda, Chatka) are used by farmers for storage of this millet. Closed structures are commonly used for storage of seeds. In present days gunny bags or nylon woven sacs are used by farmers for grain storage. However storage period for this millet varies from region to region.

Traditional food products from finger millet

Finger millet is usually pulverized and whole meal is utilized for the preparation of traditional foods. In addition to traditional foods, it is also processed to prepare popped, malted, and fermented products. Noodles for diabetic patients were successfully developed from finger millet by Shukla and Srivastava [11]. 30% to 50% finger millet proportion was blended with refined wheat flour for preparation of noodles. On the basis of sensory evaluation, 30% finger millet incorporated noodles were selected and evaluated for glycemic response compared to control. Results revealed that 30% finger millet incorporated are having low glycemic index as compared to control. Finger millet seed coat is an edible material and contains a good proportion of dietary fiber, minerals and phytochemicals. Seed coat matter (SCM) forms a by-product of the millet milling, malting and decortication; this can be utilized as composite flour in biscuit making.

Krishnan et al. [12] developed biscuit from finger millet seed coat. On the basis of sensory evaluation they found that 10% of SCM (seed coat matter) from native and hydrothermally processed millet, 20% from malted millet could be used in composite biscuit flour. Saha et al. [13] prepared biscuit from composite flours containing (60:40 and 70:30 (w/w) finger millet: wheat flour and these were evaluated for dough characteristics and biscuit quality. These reported that a composite flour of finger millet: wheat flour (60:40) was best particularly regarding biscuit quality. Muffins were also prepared by replacing wheat flour with 0%, 20%, 40%, 60%, 80%, and 100% FMF (finger millet flour), emulsifiers and hydrocolloids [14]. Effect of finger millet, emulsifiers and hydrocolloids on the batter microscopy, rheology and quality characteristics of muffins were also studied. They found that combination of additives with 60% FMF significantly improved the volume and quality characteristics of muffins. Newly food products made from finger millet which are currently being explored are noodles, vermicelli prepared either from finger millet alone or in combination with refined wheat flour [11,14]; pasta products [15,16]; halwa mixes (a sweet dish prepared with flour, sugar, and clarified butter) and composite mixes [17]; papads (flattened and dried dough products which are toasted or deep fried and used as adjuncts with a meal) [18,19]; roller dried finger millet-based soup mixes [20]; bakery products such as muffins [21]; bread and biscuits [12,13,22] and complementary foods [23] are also being prepared and marketed in selected markets. Breads from millet-based composite flours, wheat in combination with finger millet, barnyard millet, and proso millet were also prepared. Ready-to-eat nutritious supplementary foods from popped finger millet flour were also prepared by Malleshi [24]. This is a whole-grain product rich in macronutrients, micronutrients, dietary fiber, and usually mixed with vegetable or milk protein sources such as popped bengal gram, milk powder, and oil seeds sweetened with jaggery or sugar. Expanded finger millet has also been recently developed by Ushakumari et al. [25] from the decorticated finger millet. Its dietary fiber content is lower than that of popped finger millet as it is prepared from decorticated finger millet which is devoid of seed coat. Ragi soup is prepared by mixing ragi flour in water. Then this mixture is heated for 15 minutes and stirred frequently to avoid lump formation. After that the mixture is removed from heat, curd and salt is then added to it. Finally it is served either as warm or cold. In addition to the above mentioned products many other local preparations are in practice making use of finger millet depending upon the local habits. Few modern products incorporating finger millet are now available in the market such as, ragi health drink (baby vita), foodles, multi-grain noodle, and ragi biscuit.

Processing Technologies for Finger Millet

Milling

Generally finger millet is pulverized to flour for preparation of food products. First it is cleaned to remove foreign materials such as stones, chaffs, stalks etc. then passed through abrasive or friction mills to separate out glumes (non-edible cellulosic tissue) and then pulverized. Normally it is pulverized in stone mill or iron disc or emery coated disc mills. Sometimes pearling or decortications are used to dehusk the finger millet grain; it results in pulverization of both the seed coat and endosperm. Hence finger millet is invariably pulverized along with seed to prepare whole meal. Centrifugal sheller can also be used to dehull/decorticate the small millets.

Decortication

This is a very recent process developed for finger millet [26]. It is also known as debranning. This method is used for debranning of all cereals, but it is not effective for finger millet owing to its seed coat intactly attached to fragile endosperm. However hydrothermal processing is used to decorticate finger millet this involves (hydration, steaming and drying) which hardens the endosperm of grain and enables it to withstand mechanical impact. The decorticated finger millet could be cooked as such as rice is cooked.

Popping

Popping is one of the traditional methods to prepare popped finger millet flour. In this process millet is mixed with 3-5% additional water to raise the moisture content tempered for 2-4 hrs. and then popped by high temperature and short time (HTST) treatment by agitation in sand to about 230°C.This process results in development of highly desirable aroma because of millard reaction between sugars and amino acids. Popped finger millet is a precooked ready to eat product. Also it can be pulverized and mixed with protein rich sources to prepare ready nutritious supplementary food [27]. However popping contaminates the product with particles of sand which is used as a heat transfer media and thus affects its eating quality. To overcome this drawback air popping in a suitable mechanical device has been successfully explored. But this method lacks the characteristics aroma compared to that using sand [28]. Popped finger millet can be prepared at household community or at industrial level.

Malting

Malting of finger millet is commonly practiced for specialty foods. During this process bioavailability of proteins, carbohydrates and minerals are enhanced. Some B-group vitamins are synthesized and concentration of anti-nutritional factors is also reduced. Malting involves soaking of viable seeds in water to hydrate and to facilitate sprouting. These sprouts are then kiln dried. Finally the rootlets are separated from the grain manually by rubbing with hand. All these operations influence the quality of malt. Seed germination is most important step because during this process the hydrolytic enzymes are developed these cause endosperm modification and increases nutritional properties. Malting of finger millet has been successfully utilized for developing various health foods such as infant food, weaning food, milk based beverages and confectionary products [24].

Conclusion

Although potential health benefits and nutritive value of millet grains were found comparable to major cereals. Several processing technologies were found to improve nutritional characteristics of millets. Utilization of millet grains as food is still limited to populations in rural areas. This is due to lack of innovative millet processing technologies. This review provides a scientific rationale use of finger millet as a therapeutic and health promoting food. In addition for promoting utilization of millet grains in urban areas to open new markets for farmers to improve their income, developing highly improved products from millets is needed. Finger millet can be used in different food formulations for making value added products due to its well-balanced protein profile and gluten free properties. Although the consumption pattern of this millet is specific and continue to remain as such therefore its popularization in the broader range is essential and specific design of foods acceptable to the population can help in promoting the consumption of this millet.

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