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Finger Millet Processing: Review

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Abstract – **The growing public awareness about nutrition and health care research strengthen the potential of phytochemicals such as polyphenols and dietary fiber and their health beneficial properties. So that there is in need to identify newer sources of nutritional materials with the desirable functional characteristics. Millets are a major food source in arid and semi-arid parts of the world. They provide protein, fatty acids, minerals, vitamins, dietary fibre and polyphenols. Finger millet (*Eleusine coracana* L.) is one of the important minor millet which play vital role in the diet of poor people residing in the hilly region. Being rich in rich in dietary fiber, protein, fatty acid, minerals especially calcium and phosphorus, finger millet has number of health benefit like in the prevention of diabetics, weight loss, lowering the cholesterol level, bone health, prevent relaxation etc. Karnataka is leading state in finger millet production in India and each state where the finger millet is cultivated has its own traditional products. Finger millet contains some anti-nutritional factors like phytin, saponin, trypsin inhibitor, and tannin but out of these tannin content is high in finger millet. The proportion of anti-nutritional factors can be lowered to permissible limits by applying pre treatments like soaking, fermentation, decortications, germination, extrusion cooking. Now a day's number of value added finger millet products available in the market.**

Keywords: **Amino Acids, Antinutritional Factors, Finger Millet (FM), Traditional and Value Added Products.**

I. INTRODUCTION

Millets are one of the cereals asides the major wheat, rice, and maize. Millets are major food sources for millions of people, especially those who live in hot, dry and hilly areas of the world. They are grown mostly in marginal areas under agricultural conditions in which major cereals fail to give substantial yields [1]. Millets are important foods of many developing and undeveloped countries because of their ability to grow under adverse weather conditions like limited rainfall so that millet is the major source of energy and protein for millions of people in Africa. It has been reported that millet has many nutritious and medical functions [2], [3]. It is a drought resistant crop and can be stored for a long time without insect damage [1]; hence, it can be important during famine. Millets are important or the unique among cereals because of their richness in calcium, dietary fibre, polyphenols and protein [4]. Millets contain significant amount of essential amino acids particularly the sulphur containing amino acids (methionine and cysteine); they are also higher in fat content than maize, rice, and sorghum [2]. In general, cereal proteins including millets are limited in lysine and tryptophan content and vary with cultivar. However, most cereals contain the essential amino acids as well as vitamins and minerals [4], [5]. Millet does not require any special fertilizer like wheat. Finger millet is important minor millet because of excellent storage properties and the nutritive value. Finger millet is often intercropped with legumes such as peanuts, cowpeas and pigeon peas or other plants such as Niger seeds. The crop is favored due to its productivity and short growing season under dry, high temperature conditions. Now a day's, there is a sudden increase the demand of minor millets due to their health benefit and the finger millet is one of them. Finger millet is a rich source of dietary fiber, calcium and phytochemicals with nutraceutical potential [6]. Finger millet contains about 5–8% protein, 1–2% fat, 65–75% carbohydrates, 15–20% dietary fiber and 2.5–3.5% minerals [7]. It has the highest calcium content among all cereals (344 mg/100 g). The total dietary fibre (22 %) of finger millet grains were reported relatively higher than that of many other cereal grains (e.g. 12.6%, 4.6% and 12.8% respectively for wheat, rice, maize and sorghum [8], [9]. FM is a best source of micronutrients like iron, phosphorus, zinc and potassium. The nutritive value of FM is higher than that of rice and equal to that of wheat [10]. In India Karnataka is the leading state in the production of finger millet known as Ragi. It is mainly consumed in India and Africa. FM also contains phytates (0.48%), polyphenols, tannins (0.61%), and trypsin inhibitory factors. The proportion of anti-nutritional factors can be lowered to permissible limits by applying pre treatments like soaking, fermentation, decortications, germination, extrusion cooking. By applying proper processing techniques, this low cost crop can be converted in to the various traditional and commercial value added products. The present review summarizes the nutritional composition of finger millets some health benefits, traditional and commercial products of finger millet.

II. HEALTH BENEFITS OF FINGER MILLET

Millet is gluten-free therefore an excellent option for people suffering from celiac diseases often irritated by the gluten content of wheat and other more common cereal grains. It is also useful for people who are suffering from atherosclerosis and diabetic heart disease [11]. FM is an extremely nutritious cereal and is very beneficial for maintaining a good health. Finger millet contains Tryptophan amino acid which lowers appetite and helps in keeping weight in control. FM gets digested at a slower rate thus keeps one away from in taking excessive calories. [12] reported in their studies on free-radical

quenching activity of finger millet that non processed brown finger millet had the highest radical quenching activity than the processed one and postulated that tannins and phytic acid were responsible for the activity [4], [13],[14]. Phytochemicals present in FM help in slowing digestion process that controlled blood sugar level in condition of diabetics. FM is rich in Calcium which helps in strengthening bones. FM is the rich source of iron that helps in condition of Anemia. It is beneficial in conditions of anxiety, depression and insomnia. Its consumption helps in relaxing body naturally. Green FM is recommended for conditions of blood pressure, liver disorders, and asthma, heart weakness, lactating mothers in condition of lack of milk production [15].

III. Traditional Food Products of Finger Millet

Finger millet is the staple diet of majority of Southern part of India especially in the rural areas. In different areas of the country, different types of traditional products are prepared from FM. In Tamil Nadu, a traditional product keppai is prepared by boiling dried finger millet powder to form a thick mass followed by cooling. It is consumed with sambar or thick spicy soups made from tamarind extracts. In Andhra Pradesh, Ragi Sankati or Ragi muddha in the form of ragi balls is consumed eaten in the morning with chili, onions, sambar or meat curry and helps them sustain throughout the whole day. In Orissa the tribal and western hilly regions ragi is staple food. The porridge and Pithas prepared from finger millet are more popular among village people of the tribal and western hilly regions of Orissa. Bhakri is the traditional food product of Maharashtra, Satva, pole, bhakri and ambil Nachani Ladus of Goa. In Garhwal region of Uttarakhand, Maddua is a traditional product in the form of thick chapatti. The dish called badi similar to halwa is prepared without addition of sugar. In the Kumaon region of northern India Maddua is traditionally fed to women after child birth. Puttu is a traditional breakfast food of Kerla [16].

IV. Antinutritional Factors Present in Finger Millet

FM contains a number of anti-nutritional factors like tannin, cyanide, phytate, oxalate, Saponin etc. Finger millet contains high amounts of tannins than any other millet varies from 0.04 to 3.47 percent [17]. High tannin content results into poor iron availability [18] and reduced digestibility of protein and minerals [19]. Cyanide antinutritional component readily and reversibly binds to a number of proteins and enzymes in the body specially those with a metallic component. Cyanide present in FM reversibly binds to a number of enzymes and proteins containing iron including haemoglobin, myoglobin, catalase and the cytochrome enzymes [20], [21]. Phytate is a naturally occurring phosphorus compound, interference with calcium and zinc absorption [22]. Oxalates affect on calcium and magnesium metabolism [23] and from complexes with protein inhibiting peptic digestion [24]. Saponin affect the cardiovascular, central nervous system and the digestive system [25].

V. Pretreatments to Reduce Antinutrients in Finger Millet

The anti-nutrients can be lowered at permissible level by processing techniques such as cooking, soaking, germination, roasting, fermentation, extrusion technology and decortications, parboiling etc.

A. Cooking

Cooking in boiling water or by steam pressure is one of the common traditional methods of food processing. Cooking not only makes food palatable and safe but also inactivates practically all the anti-nutritional factors that are heat labile [26]. Among the heat stable factors in food legumes, tannins content in the grain is lowered to 30 per cent of the initial value [18].

B. Soaking

The antinutrient components in finger millet can be reduced by soaking the whole grain and flours for 1-2days; however, the soaking for some hours may also have beneficial effects like reduction of phytate content [27]. The extent of the phytate reduction depends on the species, pH, length and conditions of soaking. The soaking resulted in reduction of phytic acid content in the range of 39.47 and 24.17% in two different varieties of pearl millet [28], while approximately 50% in unrefined maize flour [29]. [29] Reported that the soaking results in lowering of antinutrients component such as saponins, trypsin inhibitors, polyphenols and oxalates. [30] Revealed the significant reduction of tannin content when the grains were soaked in either distilled water or NaOH for 8h, and the reduction was more pronounced when the grains were cooked after soaking in NaOH.

C. Germination

The terms sprouting, malting, and germination are used to refer to the process of soaking. [31] Stated that sprouting of finger millet results in lowering of the antinutritional factor like tannins, phytate and trypsin inhibitors activity. [31] Stated that in raw ungerminated finger millet tannin content was 914±14.4mg/100g and on germination for 0, 24, 48, and 72h it decreased by 20%, 45%, 62%and 72% respectively.

D. Fermentation

Fermentation is one of the oldest and most effective methods of producing and preserving foods and lowering the antinutrient in millets [27]. [32] Reported that natural fermentation of pearl millet decreased the polyphenols and phytic acid and no change has been reported in tannin contents. [33] Also reported that rabadi prepared from fermentation of pearl millet have low phytic acid and polyphenol content. Fermentation of cereals also helps to improve the contents of certain B vitamins like thiamine, riboflavin and niacin. For example fermentation increased thiamine content in sorghum from 20 to 47µg/g, and

riboflavin content in pearl millet from 0.19 to 0.36µg/g [27].

E. Extrusion cooking

Extrusion cooking is one of the most effective food processing technologies that can be used to produce pre-cooked and dehydrated foods. [34] Reported that extrusion cooking results in the breakdown of starch and denaturation of protein improving the digestibility. [34] Revealed that extrusion cooking also reduced phytic acid, condensed tannins, polyphenols, and trypsin, chymotrypsin, and amylase inhibitory activity of the finger millet.

F. Decortications

Decortications is a mechanical methods used to remove the outré layer of grains [27]. The reduction in polyphenols and phytate phosphorus contents on decortications of millet was 74.7% and 39.8% respectively and this may provide nutritional advantages with respect to increased bio-availability of minerals and protein. [35] reported that testa layer of the millet is highly pigmented and contributes for the bulk of polyphenols and tannin content of the millet and hence significantly reduction in the polyphenol contents occurs on decorticating the millet. Similarly phytate phosphorus is located largely in the scutellum and to a smaller extent in the aleurone cells and in view that reduction in phytate phosphorus occurs on decortications of millet [8].

G. Parboiling

Parboiling of the grain is also responsible for minimize the milling losses of thiamin, riboflavin, and niacin in the rice grain [36]. During the parboiling process the water-soluble nutrient are move from the outer layers into the inner layers of the grain and thus does not remove during milling.

VI. Value Added Products of Finger Millet

Finger millet and its flour can be great substitute for other grains such as rice, wheat and other starchy grains and now a day it is widely used in new products development and these products have been demonstrated as avenue for enhanced consumption of finger millet.

A. Multi-grain flour

Multigrain flour also known as the composite flour and the concept of multi-grain flour is not new to the human. Multigrain flour by combining wheat and finger millet in the ratio of 7:3 (wheat: finger millet) is one of the simple semi-finished products suitable for making chapatti as no Indian meal is complete without Indian style bread or roti. In the proposed blend though the gluten content is reduced significantly the making of chapatti while flattering is not affected. However the colour of the chapatti turns to slightly dark. Fortification of finger millet in chapattis not only improves the taste but also helpful in controlling glucose levels in diabetic patients very efficiently [37]. High fiber content of FM is further helpful to the individuals having the problem of constipation [38].

B. Puffed finger millet mix

Puffed finger millet grains can be converted into powder by simple grinding which can further be fortified with additional ingredients. The selection and combination of the ingredients is based on the requirement of the target groups like children, pregnant and lactating mothers etc. The ingredients are selected in such a way that no further cooking requires and hygienically packed in suitable packaging materials. The finger millet mix contains higher amount of protein, energy, calcium and iron with higher bioavailability [39].

C. Weaning food

Generally the millet malt is utilized for production of infant food and also to prepare beverages either with milk of lukewarm water with the addition of sugar since old times. Malting of finger millet grains improves its digestibility, sensory and nutritional quality as well as pronounced effect in lowering the antinutrients [40].

D. Noodles – Vermicelli

Due to The changing food habits of children and teenaged groups have created a good market for noodles in India and abroad. The demand for millet noodles particularly the noodles made out of finger millet is growing due to awareness of its nutritional properties. Noodles are also known as convenience foods prepared through cold extrusion system which become hard and brittle after drying. Noodles of different combinations were prepared such as noodles exclusively made of finger millet. Finger millet and wheat flour in the ratio of 1:1 and finger millet blended with wheat and soy flour in the ratio of 5:4:1 [41].

E. Extruded products

Extrusion technology is another novel way of transforming ingredients into value added products. Extruded products prepared from different grains are very popular now days among the all age groups and their demand is growing, one of the best examples is Kurkure very popular among children. The change in life-style is also bringing a drastic change in the food habits and the extruded foods being RTE products have become a good choice as snack foods [41].

F. Bakery products

Finger millet flour is widely used for the preparation of bakery products like biscuit, nankhatai, muffins and bread. The use of millets in bakery products will not only superior in terms of fibre content, micronutrients but also create a good potential for millets to enter in the bakery world for series of value added products. In a recent study attempts have been made to improve the nutritional quality of cakes with respect to the minerals and fibre content by supplementing with malted finger millet flour [40]. In recent years, finger millet has received attention and efforts are under way to provide it to the consumers in convenient forms [42].

G. Fermented foods

Fermented foods like Dosa and Idli are popular in many parts of India and they are very common as breakfast foods and even as the evening meals in southern part of

the India. Finger millet is widely used as one of the ingredient for these kinds of fermented foods. Fermentation lowers the antinutrients content at permissible level and improves the taste but at the sometime enriches the food value in terms of protein, calcium and fiber [41].

H. Papad

Papad is a traditional product in south india. Finger millet flour (15-20%) added in other essential ingredients such as black gram, rice and spices. [43] Reported that addition of finger millet flour (upto 60%) is possible and practiced in Karnataka.

During papad preparation finger millet flour is first cooked in water upto gelatinized and dough is prepared. Thin sheet is prepared by rolling and cutting the dough into desired shapes and sizes followed by drying of these papad pieces to desired moisture content of 7-8% (db). Since the pericarp of finger millet grain is not separated out from the starch so that it gives a little dark colour to the papad. The dark colour of papad turns to lighter after frying [41].

I. Fortification and supplementation

Fortification of millet grain foods was found to be most an effective strategy that can be used to overcome nutrient deficiencies problem of developing countries. Micronutrient deficiencies, especially of vitamin A (Retinoic acid), minerals like iron, iodine, and zinc, are widely prevalent in both developing as well as some developed countries. Out of these iron deficiency is a major public health problem in developing countries. Iron deficiency affects up to 50% of infants, children, and women of child- bearing age in poorer populations of countries like Africa, Asia, and Latin America [44]. It has been found that fortified pearl millet flour seems to be a satisfactory candidate for fortification with minerals like zinc, and so can be exploited to address zinc deficiency [45]. On the other hand, heat processing of finger millet flour improved the bioaccessibility of iron from both unfortified and fortified flour. Fortification with iron did not affect the bioaccessibility of the zinc from the flour [46]. [47] Reported that the shelf-life of the millet fortified flours was also satisfactory up to a period of 60 days, as indicated by the moisture and free fatty acid contents in the millet fortified flours.

VII. Challenges and Future Scope

From the above reviewed literature, it can be observed that nutritive value and potential health benefits of millet grains were more than the major cereals such as wheat, rice, and maize. It can be also observed that processing technologies such as cooking, germination, fermentation, decortications, parboiling, extrusion cooking, soaking, malting, and fortification/supplementation were found to improve their edible and nutritional quality, utilization of finger millet grains as food is still mainly limited to populations in rural areas at the household level and the basic reason behind is lack of awareness about nutritional value and health benefit of finger millet, lack of innovative millet processing technologies to provide easy-to-handle, ready-to-cook or ready-to-eat, and safe products and meals at a commercial level that can be used to feed large populations in urban's well as rural areas [48]. However, with an increasing population resulted in increasing demands for food. Farmer will be pressed to increase agricultural production, whether by increasing crops yields on already cultivated lands or by cultivating currently natural areas or to change current crop consumption patterns [49]. Diversification of food production must be encouraged both at national and household levels in tandem with increasing crops yields. It provides more healthful and traditional whole-grain and multigrain substitutes for refined carbohydrates can be one important aspect of therapeutic dietary modification and promoting utilization of minor-grain foods [42]. Gluten protein is well known in terms of the important role for producing easy-to-handle and high quality bakery products and some other grain foods that require elastic and extensible dough. Finger millet grains are gluten-free and based on results of some laboratory trials; they seem unable to be converted into pure-millet based bakery and some other easy-to-handle solid food products. Thus, use of finger millet grains as replacement in wheat composite flours, complementary food, and food blends seems the best method that can be used for the preparation of nutritional rich, healthy and safe, high-quality, and shelf-stable food products at home scales and commercial scales to promote utilization of finger millet grains. In addition, to produce high quality products at a commercial level for urban area's consumers, there is a need for innovative processing technologies for cooking, decortications, milling, parboiling, germination, soaking and other preparation treatments of finger millet grain. In return, a consistent supply of high-quality millet grains for industrial uses and development of millet cultivars with high essential amino acid, minerals content are needed. Evaluation of nutritive value and potential health benefits of finger millet grains and their fractions in animal and human should be performed in future research studies to support efforts for promoting minar millet utilization as food.

VIII. Conclusion

Finger millet plays an important role in diet of people residing in the hilly and tropical region because it content high amount of essential nutrient and have health benefit so it can be used in commercial products to avoid the different health related problems. The malt prepared from finger millet is a good substitute and better than Horlicks, Bourn vita, Milo etc. Finger millet consumption in urban area can be increased through its proper processing and value addition. With the advancement of post-harvest processing and value addition technologies, it has become possible to process and prepare value added products which are acceptable by both rural and urban consumers. This will not only help in increasing the profitability of its

cultivators but will also help in providing income and employment opportunities in rural area.

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