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## Finger millet (Ragi) as an essential dietary supplement with key health benefits: A review

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### Abstract

The world geography has so many millet crop producer and India serves as one of the key producers of the millets. Finger millets, a type of small-sized millets, requires larger area of cultivation for growing the crop. Finger millet is considered as a special food supplement because of its high nutritional contents in comparison to other important cereals, namely barley, rye etc. It mainly consists of minerals, dietary fiber and important amino acids. In different parts of our country, especially in South India, the rural population use finger millet (*Eleusine coracana*), popularly known as ragi, as their principal food. Ragi, among all cereals, contains greater calcium level along with antioxidants and phytochemicals. The finger millet grain possesses a high content of total dietary fiber among other cereal grains that is extremely beneficial in controlling blood glucose level in diabetic patients. Besides, it is also beneficial to patients suffering with cardiovascular disease, cancer and other cognitive diseases. Ragi can be processed through different processing methods to be used as a food supplement attractive in appearance, taste, flavor and consistency. However, despite of its beneficial effects, it is limited in use in the localities, where it is produced. There exists great opportunity for processing finger millet into several functional foods to be used by mass population of our country.

**Keywords:** finger millet, ragi, nutrients, cereals, dietary supplement, millet grains

### 1. Introduction

In the modern world, majority of the population primarily use cereals as their staple food. Among the cereals, wheat, rice and corn are mostly preferred as staple food across the globe. On the other hand, millets have been ignored as a food supplement, especially in the post green revolution scenario. Millets are cultivated around the globe as minor seeded grasses and known as cereal grains or crops. These small seeded crops form an agronomic functional group and used as human food or fodder. Semi-arid tropical region of Africa and Asia especially Nigeria and India are the producer of millets with 97% productivity and it is favorable under dry and high temperature condition and these crops require little amount of water. Millets are found in different form and differ from each other by their unique nutritional value, traits and texture. Finger millet, Pearl millet, Foxtail millet, Proso millet, sorghum, Kodo millet, brown top millet are examples of different types of millet having different nutritional composition<sup>[1, 2]</sup>. However, single crops, namely wheat and rice add to food security, but incur higher production costs. In addition, millet crops contribute towards food, fiber, fodder and agricultural security<sup>[3-5]</sup>. In different parts of Africa and India, various types of millets, viz. finger millet, pearl millet, foxtail millet and proso millet are treated as significant crop but the former one is broadly grown and have more importance. Millets have less priority in developed countries such as in United States proso millets are cultivated only for birdseed. Millets are considered as indigenous in many regions of the world. There is a belief that India and Africa have an evolutionary millet and included it as food staples. Since last 10,000 years, millets are being cultivated in East Asia. The term millet is derived from the French word *Mille*, which means thousand, with a handful of millet containing up to 1000 grains<sup>[6]</sup>. Millet belongs to the group of small-seeded species of cereal crops or grains, which are annual plants<sup>[7]</sup>.

Finger millet (*Eleusine coracana*) comes under the taxonomic family *Poaceae* and in India, it is most commonly named as Mandua or Ragi. The finger millet has an embryo and endosperm covered by seed coat known as testa. Finger millets are available in multicolor such as white, tan, red, yellow, violet and brown. The red colored finger millets are grown and cultivated worldwide such as in Srilanka, Nepal, Madgaskar, Malaysia, Uganda, Japan, different parts of Africa and India [8]. Finger millets are cultivated in 25 counties in Asia and Africa and occupies around 12% of the area dedicated for the millet crops. 1.19 million hectares area in India are covered by finger millets crop cultivation with an yield of 1.98 million tone giving an average yield nearly equal to 1661 kg per ha [9]. Finger millet is an essential food source in South Karnataka. Although Finger millets have high nutritional benefits, it has thirty times more calcium than rice but in semiarid and tropical region, it is the less focused and low utilized crops. There is enormous scope to process finger millet into various value-added food products in developing countries, as finger millets do not have gluten and hence it can be used by people with gluten allergy and those who have abdominal problem. Developing countries have vast opportunity to process and transform millet grains into

beverages and value-added food products. Furthermore, millets, as they are free from gluten, hence it is prudent to use it by stomach (abdominal) patients. In India, finger millet is traditionally processed through various methods, namely grinding, malting, and fermentation for products like beverages, porridges, idli (Indian fermented steamed cake), dosa (Indian fermented pan cake), sand roti (unleavened flat bread) [10]. The present research studies about the diversified scope of finger millet as a key food supplement with numerous health benefits in the Indian context.

## 2. Nutritional Composition of Finger Millet

Finger millet is considerably rich in micronutrients such as vitamins and minerals in comparison to world's other major cereals, wheat and rice. Especially, finger millet is the richest source of calcium and have 10 times more than wheat, maize and rice and three times greater than milk. Table 1 shows the comparative composition of various nutrients present in finger millets and non-millet cereals. The data gives the value of macronutrient content of finger millet, it contains 72.6% carbohydrates, 1.3% fat, 7.3% protein, 19.1% dietary fiber, 3.6% crude fiber and 3% minerals.

**Table 1:** Composition (per 100g grain) of nutrients in different millets and non-millet cereals [5, 11-15]

| Cereal / Millet | Protein (g) | Fat (g) | Carbohydrate (g) | Crude fiber (g) | Ash (g) | Calcium (mg) | Iron (mg) | Zinc (mg) | Thiamin (mg) | Riboflavin (mg) | Niacin (mg) |
|-----------------|-------------|---------|------------------|-----------------|---------|--------------|-----------|-----------|--------------|-----------------|-------------|
| Finger millet   | 7.3         | 1.3     | 72.6             | 3.6             | 3       | 344          | 3.9       | 2.3       | 0.42         | 0.19            | 1.1         |
| Pearl millet    | 14.5        | 5.1     | 67.5             | 2.0             | 2       | 42           | 11        | 3.1       | 0.38         | 0.21            | 2.8         |
| Little millet   | 7.7         | 4.7     | 67               | 7.6             | 6.9     | 17           | 9.3       | 3.7       | 0.30         | 0.09            | 3.2         |
| Wheat           | 14.4        | 2.3     | 71.2             | 2.9             | 1.8     | 41           | 3.9       | 1.0       | 0.41         | 5.46            | 5.5         |
| Rice            | 7.5         | 2.4     | 78.2             | 10.2            | 4.7     | 10           | 0.5       | 1.2       | 0.41         | 0.01            | 1.62        |
| Maize           | 12.1        | 4.6     | 66.2             | 2.3             | 1.8     | 10           | 2.3       | 0.46      | 0.15         | 0.15            | 1.77        |
| Sorghum         | 11          | 3.2     | 72.6             | 2.7             | 1.8     | 13           | 3.4       | 1.7       | 0.33         | 0.1             | 3.7         |
| Barley          | 11.5        | 6.4     | 80.7             | 5.6             | 2.9     | 29           | 2.5       | 2.13      | 0.19         | 0.11            | 4.6         |

### 2.1 Carbohydrates

Finger millet is composed of a high content of carbohydrates with 1.04% free sugars, 11.5% non-starchy polysaccharides and 65.5% [16]. The dietary fiber content of finger millet (11.5%) is much higher than the fiber content of polished rice, brown rice, and all other millets such as foxtail, little, kodo, and barnyard millet. In ragi, 59.4-70.2% of carbohydrate is present in the form of starch, which is considered as the main constituent [17]. The starch granules of finger millet are in polygonal rhombic arrangement and composition enriched by 80-85% amylopectin along with 20-15% amylase [18]. The non-starch polysaccharide occupies 20-30% portion of total carbohydrate present in Finger millet.

### 2.2 Protein

Finger millet has the protein percent in a range of 4.9% to 11.3% [18]. White finger millet are superior to brown varieties as it has more protein within it. The mean protein content of 7.3% is similar to that of rice, i.e., 7.9% and either equivalent or lower than the value of wheat and sorghum [17, 18]. Finger millet has prolamins and glutelin as the main constituent of

protein. The nutritional level is properly balanced in finger millet as compared to other millets. Finger millet have around 44.7% essential amino acids whose value is higher than that of 33.9% present in FAO reference protein [19]. Eleusin, the key protein content present in finger millet, is highly enriched with cystine, tryptophan, methionine and other aromatic acids and are responsible for the growth and development of human health and not available in other millet grains or cereals. Methionine percentage is high in finger millet whose value is around 5% of total protein [17]. However, as with other cereals, lysine is limiting in finger millet grain, but among the millets pearl and finger millets. Lysine is not the limiting factor in case of Finger millets, as it have most lysine. Finger millet have sufficient amount of tryptophan and threonine, which are considered as the deficient amino acid in case of cereals, wheat, rice and sorghum. Finger millet is considered as better one as it has high amount of threonine, valine and lysine and the percentage composition of sulphur-contained amino acid is equal to that of milk. Table 2 presents the key composition of amino acids in different millet grains.

**Table 2:** Typical composition of amino acids in millet proteins [11, 18]

| Millet grain   | Amino acid composition (mg/g) |      |     |     |     |     |     |     |     |     |
|----------------|-------------------------------|------|-----|-----|-----|-----|-----|-----|-----|-----|
|                | Ile                           | Leu  | Lys | Met | Cys | Phe | Tyr | Thr | Trp | Val |
| Pearl millet   | 256                           | 598  | 214 | 154 | 148 | 301 | 203 | 122 | 122 | 345 |
| Finger millet  | 275                           | 594  | 181 | 194 | 163 | 325 | -   | 191 | 191 | 413 |
| Foxtail millet | 475                           | 1044 | 138 | 175 | -   | 419 | -   | 263 | 61  | 431 |
| Proso millet   | 405                           | 762  | 189 | 160 | -   | 307 | -   | 61  | 49  | 407 |

|                 |     |     |     |     |     |     |     |    |    |     |
|-----------------|-----|-----|-----|-----|-----|-----|-----|----|----|-----|
| Little millet   | 416 | 679 | 114 | 142 | -   | 297 | -   | 49 | 35 | 379 |
| Barnyard millet | 288 | 725 | 106 | 133 | 175 | 362 | 150 | 35 | 63 | 388 |
| Kodo millet     | 188 | 419 | 188 | 94  | -   | 375 | 213 | 63 | 38 | 238 |

### 2.3 Lipids

Finger millets have the lipid contents composed of linoleic acid, palmitic acid and oleic acid and the total value is around 5.2%. Fat content in the form of free lipids is 1.3%. Finger millet grain has a low-fat content because of the small sized germ and provides a superior and significant storage system as the probability of conversion of fat into rancid is less here [11, 18, 19].

### 2.4 Minerals

Finger millet has high content of ash in comparison to other cereal grains. Diseases due to deficiency in calcium, such as disordered in teeth and bone, anemia caused by iron deficiency can be treated by adding finger millet in the diet on

daily basis. It is found that it has nearly about 1.7-4.13% of ash [11, 18]. Studies revealed that the average value of ash content of finger millet is in the range of 2.1-2.7% [11, 18, 19]. It is a calcium-enriched source of minerals in comparison to other cereals. It is a high content source of iron, magnesium, sodium, phosphorus, copper and potassium. The richest portion of minerals in finger millets are the germ, aleurone layer and pericarp. However, finger millets have anti-nutritional constituents such as oxalic acid, phytic acid, condensed tannins that may reduce the bioavailability of divalent metal ions and. It is highly enriched with calcium and iron. Table 3 presents the essential trace element composition of different millet grains.

**Table 3:** Typical composition of trace elements in millet grains [11, 18, 20]

| Millet grain    | Trace element composition (mg/100g of dry matter) |     |     |      |     |      |      |      |       |
|-----------------|---|-----|-----|------|-----|------|------|------|-------|
|                 | P   | Mg  | Ca  | Fe   | Zn  | Cu   | Mn   | Mo   | Cr    |
| Pearl millet    | 379   | 137 | 46  | 8.0  | 3.1 | 1.06 | 1.15 | 0.07 | 0.023 |
| Finger millet   | 320   | 137 | 398 | 3.9  | 2.3 | 0.47 | 5.49 | 0.10 | 0.028 |
| Foxtail millet  | 422   | 81  | 38  | 5.3  | 2.9 | 1.60 | 0.85 | -    | 0.070 |
| Proso millet    | 281   | 117 | 23  | 4.0  | 2.4 | 5.80 | 1.20 | -    | 0.040 |
| Little millet   | 251   | 133 | 12  | 13.9 | 3.5 | 1.60 | 1.03 | -    | 0.240 |
| Barnyard millet | 340   | 82  | 21  | 9.2  | 2.6 | 1.30 | 1.33 | -    | 0.140 |
| Kodo millet     | 215   | 166 | 31  | 3.6  | 1.5 | 5.80 | 2.90 | -    | 0.080 |

### 2.5 Vitamins

Millets are considered as the potentially rich contents of vitamin B. It is reported that 100 g of finger millets only have 45 µg [21]. In another study, Ray *et al.* [22] revealed that the amount of β-carotene in finger millet is too scanty and nearly about 0-1 µg. Finger millets have vitamin A with its value equivalent to six retinol. Fat and water-soluble vitamins, such as thiamine, niacin, riboflavin and tocopherols known as vitamin E plus vitamin C are present in finger millets but in other dried millet grain vitamin C is not present. The germ and aleuronic layer of finger millet are rich in water soluble Vitamin B, while only vitamins which are lip soluble are concentrated in germ [21, 22].

### 2.6 Fiber

Fiber has high nutritional value, which helps to maintain a healthy gastrointestinal function and to reduce the transit time of intestine. This will lower the total value of lipoprotein cholesterol within blood serum and blood postprandial glucose level. The fiber contents of finger millet support to enhance the bioavailability of calcium along with the development in immune system. It is active against the cancer in colon. It is recommended to take a daily diet having total fiber about 38g and 25g for men and women, respectively. Finger millet have total dietary fiber of 22% which is higher in comparison to the other millets or cereal grain such as 12.8%, 4.5%, 13.4% and 12.6% for sorghum, rice, maize and wheat respectively [23]. Finger millets have fiber contents, which are concentrated in the wall of endosperm and pericarp. It is reported that finger millets have 18.6% of fiber contents and mainly composed of lignin 7.9%, cellulose 4.7% and non-cellulosic polysaccharides 6.1% out of which water insoluble portion is 4.7% and 1.5% are water insoluble [24]. The high fiber content slows the rate of digestion, enabling consumers to work for long hours on a single meal of this millet.

### 2.7 Antioxidant activity

Finger millets are rich in several phenolic compounds, which includes tannins. The phenolic compounds exhibit antioxidant property and free radical foraging activity that makes finger millets a beneficial to health and as a potential inhibitor towards biological oxidation that may reduce the cardiovascular health risk and acts as an anti-ageing food supplement [18, 23, 24].

### 3. Processing of Finger Millet

Different techniques are adopted in food processing and developed over the long time period and the aims of processing is to make final yield more striking in both texture and flavor with consistency.

#### 3.1 Soaking or Cooking

Soaking is a most employed technique used for the reduction of anti-nutrient percentage in food. Ragi was soaked in water in a ratio of 1:10 ratio at room temperature for a period of 1 to 2 days. During soaking process, trypsin inhibitor, polyphenols, phylate, saponins and oxalates contents are reduced [25]. The nutrition quality, bioavailability and bio accessibility of minerals of millets are improved by soaking. The tannin content of finger millets is significantly reduced when it is soaked in distilled water or NaOH solution for 8 hours. It is reported that phytic acid contents also be reduced from 39.47 to 24.17%. Anti-nutrients of finger millets, which are heat labile, can be deactivated upon cooking or steam treatment [26].

#### 3.2 Fermentation

The complex material present in finger millet is converted into a simple molecule in presence of microorganism by a metabolic process, which is known as fermentation. It is reported that breakdown of protein, increase in amino

nitrogen and destruction of inhibitor takes place during fermentation [27]. Again, fermentation is the oldest and effective processing method for preservation of foods. The net protein utilization value, percentage value of niacin, riboflavin, thiamin, biological value of finger millet is improved and simultaneously anti-nutrients contents are reduced in fermentation process [23]. When endogenous grain micro flora is used in the fermentation process of finger millet flour, there is a substantial reduction of anti-nutrient contents like tannins by 52%, trypsin inhibitor activity known as TIA by 32% and phylates amount by 20 [28]. The mineral contents and its accessibility like zinc 20%, phosphorous 26%, iron 20% along with calcium 20% within finger millets is also increased in fermentation process [29]. Basappa *et al.* [30] reported that there is a significant increase in the concentration of amino acid composition of riboflavin-0.62 mg per 100g and pantothenic acid-1.6 mg per 100g profile of pantothenic acid-1.6 mg/100g in fermented finger millet, whose value is higher than the fresh finger millet. Fermentation increases the lysine content and niacin value as 4.2 mg per 100g in millets [27]. Fermentation is an important and basic step for the processing of thick porridge, thin porridge, baked and fried pancake and beverages from finger millet and which are consumed in the above form since ancient time. *Lactobacillus salivarius*, a lactic acid bacteria used in fermentation process, is considered as beneficial because it increases the amino acid portion, such as tryptophan and lysine by 17.8% and 7.1%, respectively [27, 28]. The value of Vitamin B composition present in the form of thiamine, riboflavin, niacin is also hiked from 0.19-0.36 µg per g in fermented millets [23, 26, 27]. Protein digestibility can be improvised in fermentation by the help of microbial enzymes, which helps to degrade the complex storage protein. Amylotic attack is also feasible, as the *in vitro* digestibility is increased post fermentation process due to acid production and soaking.

### 3.3 Milling or Grinding

The large portion present in the form of husk and coarse bran with a seed coat in finger millets need to be removed by dehusking and debranning process prior to consumption [26]. Some nutrient rich portion of grain known as germ and aleurone layers are slightly displaced making it as a poor nutrient. Currently, this process is carried out by the help of milling machinery and mostly the millets are grinded into powder form in plate mills for conventional food grounding. Wooden or stone mortar is used to pound the wet, moistened and dry grain. The fibrous husk can be removed by moisturizing the grain on addition of 10% water [25, 26]. Finger millet flour is obtained by moistening, grinding and clarifying. Wet milling involves overnight soaking of grains and grinding to make paste by hand or using two stones. The milled grains are hydrated quickly and transform into a soft texture and it requires less time. The kernel, 15% of which is made up of seed coats, is enriched with calcium, polyphenol and dietary fiber [28]. In general, the pulverized millet or the whole meal is utilized for the processing of dietary products. Although, seed coat of finger millet is comestible but its presence in the food will develop dark chewy textures, therefore it should be separated during the processing step. The separation of seed coat is comprised of moist conditioning, sieving and pulverizing, malting and sometimes hydrothermal decortication of finger millet is adopted. The millet starch granules, which are intact, show slight resilience towards both  $\alpha$  and  $\beta$  amylase and the scratched granules are active to enzyme attack. Although the water binding capacity

increases with starch, damage but excess value causes a fall in water binding ability of flour.

### 3.4 Roasting

Traditional roasting of grains is used primarily to enhance flavor, but other benefits include reduction of anti-nutritional factors and extension of storage life. The grinding and roasting process makes the grain consumable and retain the nutrients. The roasting and puffing are almost similar processes, however in case of puffing the volume expansion is more. The anti-nutritional chemicals such as hem agglutinin, goitrogenic agents, cyanogenic glycosides, alkaloids, saponins and trypsin inhibitor are removed during roasting and storage life span is improved by this process and commonly employed at rural and household level [23, 26]. Bioavailability of iron is higher in weaning foods processed by roasting of finger millet and barnyard. Shukla and Srivastava [31] developed a nutritious and instant baby food from finger millet by adopting processing technology comprised of roasting and malting. Roasting process was carried out in iron skillet at 125 °C for 10 min and the processed baby food after roasting, is enriched with calcium, iron and protein. Wadikar *et al.* [32] reported that roasting resulted in no significant effects on the physicochemical properties of finger millet grains. As reported, the finger millet after roasting at different temperatures and time was milled into flour and porridge. It was found that porridge viscosity decreased with increasing roasting time and temperature. Viscosity decreased by 50–60% in roasted finger millet; however, roasting did not affect the proximate composition. Roasting of seeds at higher temperatures produced undesirable flavors and darkened colors due to heat-enhanced chemical reactions. In this context, a roasting temperature of 125 °C for 10 minutes was recommended.

### 3.5 Popping

The simplified technique involved in processing of cereals to make it ready to consume is known as puffing or popping. The finger millet grain, after popping, transformed into a porous, crunchy and convenient precooked instant products with pleasant and acceptable aroma and taste. Popped finger millet is treated as a nutrients enriched food component in nutrition intervention programme [22]. Malleshi and Desikachar reported that the suitable conditions to get fully enlarged millets are a processing temperature of 250 °C and moisture contents of about 19% [33]. The popped grains are highly fibrous because after popping it is not favorable to de-bran the grain. Popped millets are the porous products having low bulk density with an attractive texture and distinct flavor. *In-vitro* nitrogen content and starch digesting ability is increased by puffing. The increased starch digestion ability makes the grain more susceptible towards enzymatic digestion by attributing a high level starch gelatinization and de-bonding of starch granules from protein.

### 3.6 Germination or Malting

In India, the most common method employed to increase the nutrition profile of finger millet is germination and its value is more than the nutritional value of germinated sorghum and germinated maize [29]. It is reported that finger millet has higher value of amylase activity than the sorghum where as some other millets take 4-5 days to achieve maximum amylase activity [33]. The nutritional value associated with biochemical changes are enriched by germination and it inhibits the fungal infection of grains. There is a continuous



increase in the concentration of  $\beta$  and  $\alpha$  amylase during the entire process of germination, which will enhance the aroma of malted foods in kilning and roasting process [26]. The most common terms those pass on to the soaking process are malting, sprouting and germination. Germination helps to enhance the nutritional value simultaneously decrease the anti-nutritional contents, such as phytic acid, trypsin inhibitor and tannin. It also increases the bio-accessibility function of minerals, such as calcium, iron and zinc present in finger [34-36]. A study on germinated finger millet revealed that the methionine and lysine contents is increased from 1.3 to 1.5 mg/100 g and 3.5 to 4.0 mg/100 g, respectively [33]. In-vitro extraction ability of iron, zinc and calcium can be improved significantly if the germination process of finger millet is carried out for 48 hours [37]. Nutritional and sensory quality as well as bioavailability of nutrients and digestibility of finger millets can be modified to a significant high level during malting process. The three types of modifications those occur in grain during malting are hydrolytic enzyme mobility, several chemical changes developed in millets or grain and changes in physical attribution such as grain softening and weakening. These modifications enable the biochemical reaction within grain, makes it water-soluble, and converts it into a less viscous. Malting process adopted for finger millet is a most common methodology in India. Malted form of finger millet is used as a nourishing food for infants and is considered as wholesome food for diabetics. There is also some losses in protein content of malted finger millets. Malleshi and Desikachar [33] in their study reported that there is a significant increase in the level of starch hydrolyzing enzyme with flavor in malted finger millets. Sprouting of finger millet increases the amount of lysine, cysteine, tryptophan and methionine. Germination and malting of finger millet leads to decrease in iron, calcium and phosphorous because of removal of seed coat. Malting of brown and white finger millet significantly increases ionizable iron and soluble zinc contents and simultaneously decreases the phytin phosphorous and tannin, respectively [27, 33]. It has been reported that growth of microflora and lactic acid bacteria is achieved during sprouting and proven beneficial for the processing of traditional foods [34]. Malted seeds produce finer flours with diminished starch-swelling capacity and reduced gruel viscosities. Lower viscosities allow greater flexibility in adjusting flour concentrations. A significant increase in vitamin C content after malting was found which was attributed to the enzymatic hydrolysis of starch by amylases and diastases, which degrade starch and produce glucose. This increased amount of glucose becomes the precursor of vitamin C. Emmanuel and Sackey [38], in their study on utilization of malted ragi in cake, reported decrease in pH and increase in titratable acidity with increase in quantity of malted ragi flour. This change may be due to the hydrolysis of fats to produce fatty acids and production of ascorbic acid during germination process.

#### 4. Health benefits of Finger Millet usage

The polyphenolic finger millet is the potential resource of healthy food supplements and has health benefits. The brown variety of finger millet has 96% of phenolic acid contents and more threonine, valine and lysine in comparison to white and other varieties of millets [39]. In addition to these, black finger millets also have dry weight fatty acid 8.71 mg/g and dry weight protein 8.47 mg/g [40]. The diet having finger millet helps to reduce cholesterol in diabetic and reduction of blood glucose by 36%. It also have anti-ulcerative properties.

#### 4.1 Finger millet as a diet supplement for diabetes

The phytochemicals present in finger millet slows down the digestion process resulting in blood sugar level control as well as improving antioxidant level in the body [41]. Finger millet have high fiber contents in comparison to wheat and rice and a low response towards glycemic process means a low ability to enhance blood sugar and absorptivity of starch [42]. The seed coat phenolic of finger millet acts as an inhibitor that helps to reduce the postprandial hyperglycemia through restricting the role of enzymes, such as amylase, alpha-glucosidase etc., essential in hydrolysis of complex carbohydrates [15].

#### 4.2 Finger millets for lowering cardiovascular diseases

Methionine, threonine and lecithin, the two amino acids present in finger millets helps to remove unnecessary fat from liver and decrease the cholesterol level and encumbers the fat formation. Again, finger millet possesses low concentration of serum triglycerides. The possibility of cardiovascular disease is minimized with consumption of finger millets through reduction in plasma triglycerides [43].

#### 4.3 Finger millets for celiac diseases

Celiac disease is an immunity-based disease that is caused due to the absorption of gluten in genetically vulnerable persons. Finger millet is free from gluten, hence acts as a viable option for individuals suffering from celiac diseases and patients sensitive to gluten, those often dislike the gluten composition in wheat and other used cereal grains [44].

#### 4.4 Finger millet for protein /amino acids

Amino acids play a vital role in functionalization of body and repair of tissues. Finger millets are rich in tryptophan, valine, isoleucine, methionine and threonine.

- Amino acid improves the metabolism of body, helps to maintain the coordination in muscle and tissue healing as well as contributes in balance of nitrogen content in the body.
- Isoleucine repairs the muscle disorder and contributes to the blood formation, which will helps in bone formation, and Isoleucine helps in muscle repair, blood formation contributes to bone formation and recovery of healthy skin.
- Methionine an essential amino acid plays a vital role in elimination of excess fat, helps to facilitate different function and process of body and acts as a Sulphur provider in body, which is required for the production of natural antioxidants glutathione.

#### 4.5 Finger millets for the treatment of anemia

Finger millet is rich in iron and used in diets to get recovery from anemic condition and malnutrition.

#### 4.6 Finger millets for relaxation

Body relaxation occurs naturally by the consumption of finger millet. Ragi is used to treat depression, insomnia, migraines and anxiety.

#### 4.7 Finger millets for reducing aging

Finger millets are rich in antioxidants and phenolics those are key parameters for good health, aging and metabolic syndrome. Finger millets curb cross-linking of collagen and glycation those are responsible for aging in individuals [45].

#### 4.8 Finger millet for other health benefits

- Consumption of finger millet on a regular basis will increase malnutrition, cures degenerative diseases and slows down the early ageing. Especially green finger millets is beneficial for the patients those have heart problem, liver disorder, blood pressure and asthma.
- Finger millets are highly enriched with nutrients and proven beneficial to maintain good health. However, the patients having Urinary Calculi, as it will produce more oxalic acid, should avoid a high dose intake. Ragi could be enjoyed in different forms and preparations.

#### 5. Conclusion

Finger millet is considered and promoted as an essential primary healthy food supplement across abroad and India. The functional and nutritional activity have been studied and on review it is found that in comparison to other cereals, finger millet is enriched with several types of minerals, antioxidants, fatty acids and minerals which have a great importance and significance in a healthy nutrition rich diet and essential to maintain a healthy life. It could help the people in rural area as a dietary complement those who are suffering from insufficient malnutrition because of energy-protein deficiency. Finger millet are available in different processed value-added form in a balanced proportion of protein contents and with enhanced activity free from gluten. Finger millet has a specific pattern of consumption and accordingly, it is necessary to have specific design and promotional activity to promote finger millets usage as an essential dietary supplement in our day-to-day life.

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