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REVIEW ARTICLE

A comprehensive review on health benefits of finger millet

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ABSTRACT

Cereal grains are the most important source of food and play a major role in human diets all over the world. Millet is one of the most important drought-resistant crops, providing a significant source of carbohydrates and proteins to people living in the semiarid tropics of Africa and Asia. Finger millet is one of the ancient millets in India. In terms of nutritional composition, finger millet ranks higher than the other cereal grains. Finger millet contain both water soluble and water insoluble vitamins. It is a good source of dietary fiber, minerals, phytates and amino acids. Processing of finger millet involves soaking, malting, popping, milling. Food processing procedures have been found to boost the nutritional quality of food by improving the digestibility and bioavailability of nutrients, while simultaneously reducing the presence of anti-nutrients. The plant possesses various health-promoting qualities, including anti-diabetic, anti-diarrheal, antiulcer, anti-inflammatory, anti-tumerogenic, antibacterial, phytochemical activity, enzyme inhibitory capabilities, and antioxidant properties. Furthermore, people afflicted with cardiovascular disease, cancer, and other cognitive disorders also experience advantageous effects..

Keywords: Finger millet, boosts immunity, gluten-free, rich in dietary fiber.

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INTRODUCTION

Millets have been cultivated and consumed on the Indian subcontinent for the past 5,000 years. Millets are annual, warm-season, small-grained cereals belonging to the plant family, Poaceae. They are rain-fed, hardy grains with minimal water and fertility requirements in comparison to other popular cereals. Millets are of two types – major millets such as sorghum, pearl millet, finger millet and minor millets such as foxtail, little, kodo, proso and barnyard millet. Finger millet is also known as "Ragi". It is an important staple food in eastern and central Africa and also popular in some parts of India especially in south India (Majumdar et al. 2006). Finger is native to East Africa (Ehtiopian, Ugand and highlands), that supply a major portion of calories and protein to a large segments of population in these countries especially for the people of low income groups (Kennedy et al. 2006). Finger millet is small sized millet that requires a large area for cultivation. Finger millets exhibit a range of colours, including white, red, yellow, and brown, among others. Finger millets with a red hue are cultivated in several regions globally, including Sri Lanka, Nepal, Malaysia, Uganda, Japan, diverse portions of Africa, and India, among others (Jagati et al. 2021). It is an annual

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herbaceous plant, which has high amount of protein, calcium, fiber and energy as compared to other crops like wheat, paddy, sorghum oats etc. The seed of finger millet is a good source of dietary fiber, iron, essential amino acids (Chamoli et al., 2018). The agronomic advantages of finger millet that include their ability to grow in diverse and adverse environmental conditions, easy to cultivate, and giving higher yield with good storability (Okwudili et al., 2017).

According to the US National Research Council (1996), finger millet is more nutritious than most cereal grains with respect to minerals, dietary fiber and essential amino acids. Finger millet has several medicinal properties like hypoglycemic properties, hypocholesterolemic and anti-ulcerative effects etc. (Chethan and Malleshi ., 2007). Finger millet also contains various phenolic compounds exerting antioxidant properties (Dykes and Rooney, 2006). Finger millet is the fourth most important millet in the globe, after sorghum, pearl millet, and foxtail millet (Upadhyaya et al., 2007). Based on a recent study, global finger millet production amounts to approximately 4.5 million tonnes annually. Africa and India have yearly production rates of 2.5 million tonnes and 1.2 million tonnes, respectively. Finger millet, which constitutes around 85% of the total millet production in India, is planted on a land area of 1.19 million hectares inside the country (Sakamma et al., 2017). According to Amadou et al. (2011), finger millets are cultivated in 25 countries across Asia and Africa, which accounts for around 12% of the land area designated for millet crops. Additionally, 1.19 million hectares of land in India are covered by finger millets crop farming.

As finger millets are gluten-free grains, they can be consumed by those with a gluten allergy or an abdominal condition. As a result, the potential exists in developing nations to transform finger millet into a variety of food products with added value. There are extensive opportunities for developing nations to transform millet grains into beverages and food items with added value. In India, finger millet is traditionally processed by grinding, malting, and fermentation to make beverages, porridges, idli (Indian fermented steamed cake), dosa (Indian fermented pan cake), and sand roti (unleavened flat bread) (Singh and Raghuvanshi, 2012).

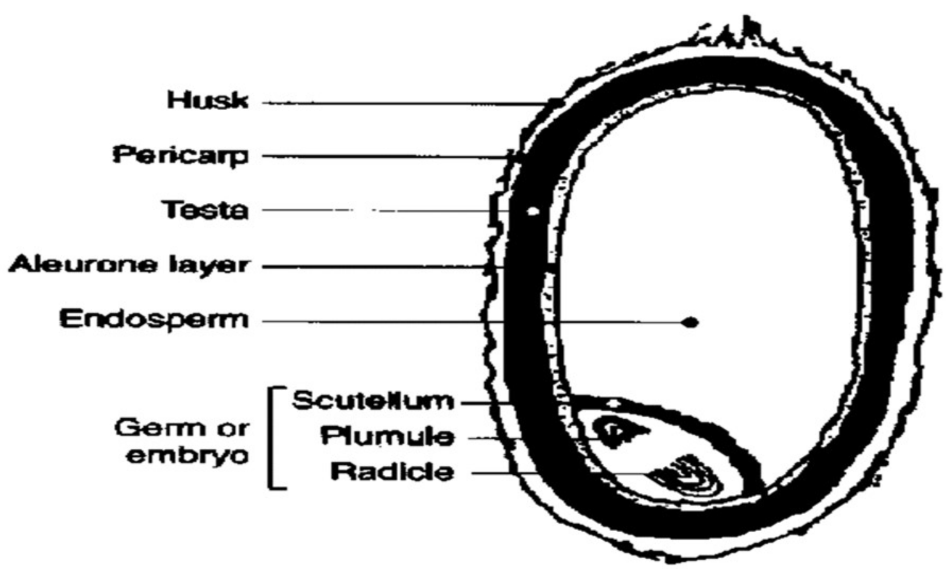

Figure 1: Structure of finger millet grain. Source: **Ramashia, et al., (2018)**

Finger millet grains are small-seeded caryopsis (about 1.2–1.8 mm in diameter) and are mostly spherical in shape (Fig. 1). They have light brown or brick red coloured seed coat with the thin membranous pericarp which is loosely attached to cover the entire seed which is usually detaches during processing (Shobana and Malleshi, 2007). Sood et al. (2017) reported that finger millet grains consist of a unique grain characteristic of an utricle instead of a true caryopsis, thus making the pericarp not to be completely fused with the testa. The term caryopses refer to a single-seeded fruit in which the pericarp surrounds the grain, adheres tightly to the grain coat (Wrigley and Batey, 2010) and Patel et al. (2014), reported that finger millet has a brick red-coloured seed coat. The main anatomical parts of the finger millet grains are pericarp, germ and the endosperm (Figure 1). The pericarp is an outer thin layer which covers the grain and is also known as the glume. The grain pericarp consists of three layers: the epicarp (outermost layer), mesocarp (middle layer) and endocarp (inner layer) (Ramashia et al., 2018).

NUTRITIONAL COMPOSITION

Finger millet (FM) ranks higher in nutritional composition than other cereal grains, although it is grossly underutilized (Sood et al. 2016). FM is a variety of cereal grains that exhibits a higher concentration of essential micronutrients, including vitamins and minerals, in comparison to other cereals such as wheat and rice. FM is considered to be a highly abundant source of calcium (Jagati et al., 2021).

Carbohydrate

Deaton and Dreze (2009) report that the carbohydrate content of finger millet is relatively high at 65.5% starch, 11.5% non-starchy polysaccharides, and 1.04% free sugars. Ragi's primary components are the carbohydrates in the form of starch. Finger millet contains amylopectin (80-85%) and amylase (20-15%), both of which enrich the starch granules' polygonal rhombic structure (FAO, 1995). According to Wankhede et al. (1979), the nutritional composition of finger millet includes 59.5% to 61.20% starch, 6.2% to 7.2% pentosans, 1.4% to 1.8% cellulose, and 0.04% to 0.6% lignin, making it more nutritious than brown rice, polished rice, and other millets like foxtail, little, kodo, and barnyard millet. Finger millet has been analysed and found to provide 1.04% free sugar, 65.5% starch, and 11.5% dietary fibre, as reported by Gopalan et al. (1999).Sucrose makes up the bulk of the sugar content in finger millet (0.20-0.24 g/100 g) (Himanshu et al., 2018).

Protein

This millet has a protein level of 6-8%, as reported by Hulse et al. (1980). Protein in finger millet primarily takes the form of prolamins and glutelin. According to Bhatt et al. (2003), the crude protein content of most finger millets was between 5.6% and 12.70%. The percentage of essential amino acids in finger millet—around 44.7%—is higher than the percentage in the FAO reference protein (33.9%; Mohamed et al., 2009).Finger millet has high levels of the essential amino acids lysine and methionine, which are sometimes in short supply in plant-based diets but not in this one (McDonough et al., 2000). In comparison to other millet species, finger millet has a greater methionine level (194 mg/g) (Prashantha and Muralikrishna, 2014). Finger millet contains between 24.6% and 36.2% prolamin (Lupien, 1990) of its total protein. Finger millet has 99.1 mg of soluble proteins per 100 g and a high concentration of tryptophan and threonine, as reported by Antony and Chandra (1998). Sulfur-containing amino acids in finger millet are similar to those in milk (Antony et al., 1996). According to the World Health Organization's 2015 Report, eleusinin, the primary protein found in finger millet, is rich in aromatic acids like cystine, tryptophan, and methionine, which are essential for human development and growth.

Fat content

Finger millet has superior keeping qualities than othercereals like pearl millet, barnyard millet, and foxtail millet as it contains a lower fat content.The fat content in finger millet is between 1.3 and 1.8% (Thapliyal and Singh, 2015). About 1.2%-1.4% of fat content is present in the brown and white varieties of finger millet (Seetharam, 2001). Sridhar and Lakshminarayana, (1994), reported that the total lipid in finger millet consists of free lipids (2.2%), bound lipids (2.4%), and structural lipids (0.6%) and also reported that finger millet contains predominantly oleic, palmitic and linoleic acids with a little quantity of linolenic acid. The amounts of saturated and unsaturated fatty acids present in finger millet are25.6% and 74.4% of total fatty acids, respectively. According to Mahadevappa and Raina, (1978) in finger millet, lipids are mostly triglycerides andcan reduce the incidence of duodenal ulcer. Finger millet contains lipid content of 1.5%, Oleic (49%), linoleic (25%) and palmitic acids (25%) are predominant fatty acids of this millet. In finger millet, about 72% of total lipids are present as neutral lipids, 13% as glycolipids and 6% as phospholipids. Muthamilarasan et al., (2016), observed that the essential fatty acid like palmitic acid and linolenic acid present in finger millet are essential for the development of brain and neutral tissue.

Dietary fiber

According to American Association of Cereal Chemist (2001), dietary fibre (DF) is a multi-component mixture of plant origin and forms the main food constituent that influences the rate and extent to which blood glucose increases after ingestion of a carbohydrate or analogous carbohydrate food. The primary plant dietary fibres include non-starch polysaccharides, non-α-glucan oligosaccharide, resistance starches, some polyols, and modified starches etc. (Lafiandra et al., 2014). The dietary and crude fibres of finger millet as reported by Rathore et al. (2019) are 18.6% and 4.3%, respectively. However, Ramulu and Rao (1997), reported that finger millet contain 12% total dietary fibre, 11% insoluble dietary fibre, and 2% soluble dietary fibre. Recent studies have shown that millet contain about 22.0% of dietary fiber and it includes the non-starch polysaccharides (water-soluble and water-insoluble polysaccharides, hemicellulose A and B), cellulose, pectin, and lignin (Subba Rao and Muralikrishna 2001).Regular consumption of dietary fibre reduced risk of all-cause mortality and also reduce cardiovascular diseases, cancer, diabetes, respiratory disease, infections, and other causes (Fuller et al., 2016).

Minerals

The total ash content is higher in finger millet than the other commonly consumed cereal grains. According to US National Research Council, (1996), finger millet is a good source of minerals, particularly calcium, which can be 5–30 times more than in most other cereals. Finger millet also has high levels of potassium, iron, magnesium, copper, sodium and phosphorus (Obilana and Manyasa, 2002). The different layer of finger millet such as pericarp, aleurone layer and germs are rich in minerals (Serna-Saldivar, 1995). According to Vijayakumari et al. (2003), finger millet is one of the richest sources of calcium and iron. Sankara Vadivoo et al.(1998), reported that calcium content of 36 genotypes of finger millet ranged from 162 mg%-487 mg% with mean value of 320.8 mg%. However, Bhatt et al. (2003) observed that finger millet contains 344 mg% calcium. The zinc content of the 16 different varieties of finger millet ranged from 0.92 mg%-2.55 mg% with a mean value of 1.34 mg%. The phosphorous content ranged from 130 mg% to 295 mg% with a mean value of 180.43 mg% (Singh and Srivastava, 2006). According to Babu et al. (1987), 3.3 mg% to 14.8 mg% of iron content is present in finger millet. Joseph et al. (1959), observed that nearly 49% of total calcium content of finger millet is present in the husk. According to Devi et al. (2014), the amounts of phosphorus, potassium, magnesium, calcium, sodium, zinc, iron, manganese, and copper in finger millet are 130–283, 430–490, 78–201, 162–398, 49, 2.3, 3.3–14.39, 17.61–48.43, and 0.47 mg/100 g, respectively.

Vitamin

Vitamins present in FM grains are important micronutrients required by the human body for normal growth. Vitamins are grouped into two categories such as fat-soluble and water-soluble vitamins and a lack of vitamins may lead to vitamin deficiencies which can cause health problems (Ottaway, 2008). Both water-soluble and fat-soluble vitamins like thiamine, riboflavin, niacin etc. are present in finger millet. The water-soluble B-vitamins are concentrated in the aleurone layer and germ, while the liposoluble vitamins are mainly located in the germ (Serna-Saldivar, 1995). The finger millet grains are lacking in vitamin C but have higher levels of riboflavin, niacin, thiamine, and folic acid (Vidyavati et al., 2004). Asharani et al. (2010) also reported finger millet contains the tocopherol concentration of 4.1 mg/100 g. Finger millet contains 6 retinol equivalents of vitamin A and 45 µg/ 100 g of carotene (Thapliyal and Singh, 2015). Eshak and Arafa, (2018), reported that finger millet contains 0.42 mg of thiamine composition in it and riboflavin composition in finger millet is 0.19mg (Penberthy and Kirkland, 2020).

PROCESSING OF FINGER MILLET

For converting the grains to edible forms of food products, modern and traditional methods of processing are used. Methods of food processing have been developed over the centuries that make the final product more attractive in flavour, appearance, taste, consistency etc. The common methods of processing of finger millet grains include soaking, malting, popping and milling.

Soaking

According to Banusha and Vasantharuba, (2013), soaking is process where grains are added to distilled water to steep the grains for a period of 12 hours or for overnight at the temperature of 30 to 60°C. When finger millet is soaked in distilled water or in NaOH solution for 8 hours, tannin content of finger millet is reduced and phytic acid content is also reduced up to 39.47-24.17% (Kakade and Hathan, 2015). Hotz and Gibson, (2007), reported that when finger millet is soaked in water for a few days i.e for one to two days at room temperature, it reduced some anti-nutritional elements, which increases the bioavailability and bioaccessibility of minerals and the nutritional quality. According to Patel et al. (2018), phytate and trypsin inhibitor activity is decreased by 13.22% and 13.51%, respectively after soaking. Shigihalli et al. (2018) demonstrated that when three different types of finger milletare soaked in water for 48-hour, 15–18% phytic acid content is reduced.

Germination

It is traditional process in which the unhusked grains are soaked in water for 2-24h and then spread it on a slightly wet cloth for 24-48h or incubate it at 30 °C for 48 h (Shimray et al., 2012). According to Pushparaj and Urooj (2011), germination of grains requires moisture, oxygen, and a favourable temperature to enhance the nutritional composition and to improve the functional properties of seed. During germination, the protein content, bioavailability of minerals and dietary fiber increases in the grains and reduces anti nutrient such as phytic acid content, tannin polyphenols etc. (Ghavidel and Prakash, 2007). Chove and Mamiro, (2010), reported that germination is used to soften the kernel structure and to improve the nutritional composition of grain.

Malting

According to Sarkar et al. (2015), malting is a type of combined process of steeping, germination, and drying. In Africa malting is a common technology for malted finger millet grains which are considered of best quality as compared to malted sorghum and maize. The content of crude fat, fibre, vitamin-B and C and minerals like Ca, P, Na, Mg etc. in finger millet increases during malting process. Sakamma et al.(2017), reported that during malting process seeds are soaked in the water for a period of time to make them hydrated. During soaking of seeds, germination takes place that results the sprouting in the seeds which promotes the development of hydrolytic enzymes. During malting, there are three types of changes occurs such as hydrolytic enzyme mobility, several chemical changes developed in millets and changes in physical attribution such as grain softening and weakening. These changes enable the biochemical reaction within grain, makes it water-soluble, and converts it into a less viscous (Jagati et al. 2021).According to Chinenye et al. (2017), the phytin content, phosphorous content and tannin content is decreased during the malting of brown and white finger millet. Hemalatha et al. (2007) reported that the phytate content of finger millet (417 mg/100 g) is higher than values reported for sorghum, barley, rice, and maize. Udeh et al., (2018), reported that the changes in phytic acid during malting are an indication of the dissociation of phytate rather than degradation. According to Hejazi and Orsat, (2016), the total phenol content is reduced to 25% during the malting of finger millet at 26 degree C for 48 hour and a linear correlation was observed between the phenol content and antioxidant activity.

Popping

Puffing or popping is a traditional method used for the preparation of ready-to-eat and stable shelf-life products (Dutta et al.2015). According to Mishra et al. (2014), popping is a simultaneous starch gelatinization and expansion process, where the grains are exposed to high temperatures for short time. According to Premavalli et al. (2003), during popping process, finger millet is mixed with 3-5% water for 2-4 hours to increase the moisture content of the grain and then popped it by high temperature and short time (HTST) treatment. During this process, millard reaction occurs between sugar present in the aleurone layer and amino acid which results the development of highly desirable aroma in the grains. This popped finger millet can be pulverized and mixed with protein rich sources to prepare nutritious supplementary food. Verma and Patel, (2013), reported that the vapour pressure of the grain increases during popping and the moisture present in the grain turns into steam so that the gelatinization of the starch takes place. During popping, the grains are dehydrated to low level of moisture content of about 3-5% as a result the shelf-life of popped finger millet grains increases. Now-a-days modern air puffing machines have been developed which can be used for mass production of puffed or popped millet grains. Popping enhances appearance, colour, taste and aroma of the processed raw materials (Saleh et al., (2013).

Milling

It is the most commonly used traditional processing method to convert cereal grains into flour by using wooden or stoned mortar and pestle. Generally, finger millet is pulverized to flour for preparation of food products. Before milling of finger millets, the grains are cleaned to remove the foreign particles like small stones, stalks, chaffs etc. and then passed through the friction mill to separate the glumes and then pulverized (Gull et al. 2016). According to Kakade and Hathan, (2015), Finger millet contains a large portion of husk and bran so it requires dehulling and debranning before consumption.Thomas and Karuna, (2019), reported that during milling process, about 10% of water is added to facilitate the removal of fibrous husk. The main object of milling is to remove the bran or seed coat of the grains.According to Devi et al., (2014), the testa of finger millet, which is generally rich in dietary fiber and micronutrients, is milled during milling process to prepare flour and the whole meal is utilized in the preparation of traditional foods, such as roti (unleavened breads), ambali (thin porridge) and mudde (dumpling).Some of the phytochemicals such as phytates and tannin present in finger millet is removed during milling which improves the bioavailability of iron (Singh and Raghuvanshi, 2012). For milling of grains, modern and conventional methods of milling processing are used that includes conventional stone mill, bar mill, hammer mill, ball mill etc.

HEALTH BENEFITS

Finger millet (Eleusine coracana) is known for several health benefits and some of the health benefits are attributed to its polyphenol and dietary fiber contents (Devi et al. 2014).According to Mathanghi and Sudha,(2012), ragi (Eleusine coracana) is a good source of carbohydrates, proteins, dietary fiber, and minerals, making it an essential staple food for people from low socioeconomic groups and those are suffering from metabolic disorders such as diabetes and obesity. There are many properties found in finger millet including antioxidants, anti-mutagenic, anti-carcinogens, anti-inflammatory properties, anti-oestrogenic properties, and anti-viral properties (Ferguson et al. 2001). Health benefits can be classified on the basis of presence of different components in the finger millet. Finger millet contains polyphenols, tannin, phytates etc. (Chamoli et al., 2018). Some of the health benefits of finger millet are discussed below-

Finger millet as a diet supplement for diabetes

High dietary fiber and phenolic content present in finger millet are very beneficial for diabetic patients. Pradhan et al. (2010) reported that ragi is a humble grain with low glycemic index which is suitable for diabetic patients. Brown ragi contains 96% of phenolic content which is higher than the white variety. According to Kumari et al. (2002), finger millet hashigher fiber contents than wheat and rice and a low response towards glycemic process means a low ability to enhance blood sugar and absorptivity of starch. Finger millet contains some phytochemicals that slows down the digestion process resulting in blood sugar level control as well as improving antioxidant level in the body (Hegde et al. 2005). The phenolic compound present in seed coat 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., and essential in hydrolysis of complex carbohydrates (Singh, E. 2016).According to Kumari et al. (2002), millets help to lower blood glucose levels and improve insulin response. Chandraet al. (2016), reported that the regular consumption of finger millet products can eliminate insulin resistance by 43 percent and reduce fasting glucose by 32 percent. Geetha et al. (2020) studied and found that the high amount of dietary fibre in diabetic meal mixes helps to slow down the release of glucose, and the high concentration of phytochemicals will help to prevent cell damage caused by the generation of free radicals. A significant amount of calcium and iron are also present in finger millet. Additionally, vitamin D and calcium must be consumed in diabetes, making finger millet crucial for those with the disease (Kanorwala et al.,2022).

Cancer treatment

The phenolics compound of millets may be effective in the prevention of cancer initiation and progression in vitro (Chandrasekara and Shahidi, 2011). Coulibaly, et al., (2011), founded that phytate present in millets are associated with reduction in cancer risk.

Finger millets for the treatment of celiac disease

Finger millet is considered as an alternative food for celiac patients (Kakade and Hathan, (2015). Celiac disease is an immunity-based disease that is caused due to the absorption of gluten in genetically vulnerable persons. Finger millet is a gluten free grains, hence it 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 (Saleh et al., 2013).

Anti-ulcerative property of finger millet

According to Tovey et al. (1975), Finger millet incorporated diet prevents mucosal ulceration. Mahadevappa and Raina, (1978) reported that the lipids of finger millets can reduce the incidence of duodenal ulcer.

Anti-tumerogenic effect of finger millet against K562 chronic myeloid leukemia (CML)

According to Holyoakeet al. (2002), chronic myeloid leukemia (CML) is a form of leukemia (virulent blood disease) characterized by increased and unregulated growth of myeloid cells in the bone marrow leading to their accumulation in the blood. Rowley, et al. (1973) reported that this is a disorder involving proliferation of mature granulocytes and is associated with Philadelphia chromosome formed from a reciprocal translocation. Although the development of tyrosine kinase inhibitors (TKIs) has revolutionized the treatment of CML. (Alvarez et al. 2007). According to Senet al., (2011), finger millet is a highly nutritive cereal and is used as a remedy for many infections including the leukemia. Recently seed purified extract of finger millet gained the importance of anti-proliferative activity on K562 chronic myeloid leukemia because finger millet seeds contain a bifunctional complex of alpha-amylase-trypsin inhibitor more commonly called RBI (ragi bifunctional inhibitor), that inhibits alpha-amylase and trypsin simultaneously. RBI is a monomeric protein made of 122 amino acids containing five intra-molecular disulfide bonds and the gene responsible for the encoding RBI has been cloned from finger millet seeds and expressed functionally in Escherichia coli. As finger millet is relatively inexpensive and can be administered orally, there is a definite possibility that it will have a therapeutic role on patients with chronic myeloid leukemia.

Finger millets for the treatment of cardiovascular disease

Lee, et al. (2010) reported that finger millet may prevent cardiovascular disease by reducing plasma triglycerides in hyperlipidemic rats. Finger millet has lower concentration of serum triglycerides. According to Karki et al. (2020), Finger millet an ideal food for a healthy heart and circulatory system because it has cholesterol reduction properties. Methionine, threonine and lecithin are the main amino acids present in finger millets that help to remove unnecessary fat from liver and decrease the cholesterol level. Finger millet also contains low concentration of serum triglycerides. The possibility of cardiovascular disease is minimized with consumption of finger millets through reduction in plasma triglycerides (Lee et al., 2010).

Improvement of haemoglobin content in children

Finger millet is excellent source of natural iron. Germinated finger millet food products provide a general improvement on haemoglobin status (Tatala, et al., 2007).

Finger millet for protein /amino acids

According to Jagati, et al. (2021), finger millet is rich in tryptophan, valine, isoleucine, methionine and threonine. Amino acid helps to maintain the coordination in muscle, improves the metabolism of body, and tissue healing as well as contributes in balance of nitrogen content in the body. Isoleucine helps in muscle repairing, blood formation, contributes to bone formation and recovery of healthy skin. Methionine an essential amino acid helps in elimination of excess fat, also 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.

Production of anti-hypercholesterolaemic metabolites

According to Venkateswaran and Vijayalakshmi, (2010), when finger miller undergoes solid state fermentation it results production of metabolites like statin viz. pravastatin, lovastatin, monacolin J, pravastatin and mevastatinknown as monacolins. These metabolites inhibit the enzymatic conversion of hydroxymethyl-glutarate to mevalonate by HMG- CoA reductase, which is the important step in the biosynthetic pathway of cholesterol.

Anemia treatment

Iron deficiency anemia is a serious global public health problem. As per the World Health Organization (WHO) report, worldwide, 47% of preschool children (< 5 years), 42% of pregnant women, 30% of non-pregnant women (aged 15–50 years), and 12.7% of young men (> 15 years) are anaemic. Iron deficiency anemia (IDA) adversely affects the growth and cognitive development in children; cognitive, physical, and psychological health in non-pregnant women, and maternal and neonatal outcomes in pregnant women. According to Anitha et al. (2019), many factors cause IDA (Iron deficiency anemia) including, gut health, dietary iron deficiency, bioavailability, folic acid deficiency, Vitamin C, Vitamin A, and Vitamin B12 deficiency. Jagati et al, (2021), reported that finger millet contains high amount of iron and is used in diets to get recovery from anemic condition and malnutrition. According to Murtaza et al., (2014), finger millet is good for the people suffering from protein-energy malnutrition and is an excellent source carbohydrate (80%) and protein (7–9%) with essential amino acids like valine, methionine, and tryptophan. It also contains minerals like calcium, phosphorus, potassium, and iron and vitamins like and thiamine, niacin, and riboflavin are also abundant. Finger millet is low in fat content and is good for obese people. Supplementation with the bran of finger millet helped to prevent high-fat diet-induced obesity and increased the abundance of beneficial gut microflora in rodent models.

Antimicrobial activity

According to Radhajeyalakshmi et al. (2003), the protein extracts of millets are highly effective that inhibit the growth of pathogenic fungi such as Rhizoctonia solani, Macrophominaphaseolina and Fusarium oxysporum.Viswanath et al., (2009), observed that the polyphenol extract of finger millet which is exracted from the seed coat and whole flouractive against Bacillus cereus, Aspergillus niger and fermented finger millet extract suppress growth of Salmonella sp., Escherichia coli.

Wound healing property

According to SK and Sudha, (2012), wound healing is determined by inflammation, a vital and protective response offered by the injured cells at the wound site that starts the process of tissue repair. The perfect wound healing process is interrupted in diseased conditions like diabetes and age associated biochemical phenomenon due to increased level of reactive oxygen species (ROS). Hegde, et al. (2005), reported that wound healing is impaired in diabetic patients and studies have shown that finger millet extracts results in ameliorating this impairment by improving the nerve growth factor (NGF) production and improved antioxidant status. Rajasekaran et al., (2004) reported that ragi feeding improved the antioxidant status on skin which hastened the dermal wound healing process.

Finger millet for the treatment of cataractogenesis

Cataractogenesis is the process of cataract formation. Chethan et al. (2008), reported that the polyphenols present in finger millet is used as the mode of inhibition of aldose reductase from cataracted eye. According to Chethan, et al., (2008), finger millet seed coat phenolics such as gallic, vanillic, syringic, ferulic, quercetin, trans-cinnamic, p-coumaric, protocatechuic and p-hydroxybenzoic are identified for inhibiting cataract of the eye lens to inhibit reversibly aldose reductase.

Antibacterial activity

According to Viswanath et al. (2009), the seed coat extract showed higher antimicrobial activity against *Bacillus cereus* and *Aspergillus flavus* compared to whole flour extract. Banerjee, et al., (2012),reported that phenolic content and flavonoids (quercetin)content of finger millet inhibit oxidation of microbial membranes and microbial enzymes leading to inhibitory activities of proliferation of bacterial cells such as *E. coli, B. cereus, Listeria monocytogenes, Staphylococcus aureus,* *Streptococcus pyogenes, Serratia marcescens, Proteus mirabilis, Pseudomonas aeruginosa, Klebsiella pneumonia* and *Yersinia enterocolitica*. Ilango and Antony (2014) found that the microbiological quality-total bacterial count (TBC), lactic acid bacteria (LAB) count, yeast-mould count (YMC), coliforms at 35°C and pathogens and also found no *Staphylococcus* sp. and *Listeria* sp.

Antioxidant property

According to Sripriyaet al. (1996), the importance of antioxidant compounds are increasing due to their main roles as lipid stabilizers and as suppressors of excessive oxidation that causes cancer and ageing. Their stable radical intermediates prevent the oxidation of various food ingredients, particularly fatty acids and oils, phenolic acids and their derivatives, flavonoids and tannins present in millet seed coat are of multifunctional and can act as reducing agents (free radical terminators), metal chelators, and singlet oxygen quenchers. Higher antioxidant capacity of finger millet is attributed to the high total phenolic content as well as flavonoids such as catechin, gallocatechin, epicatechin, procyanidin dimmer, levels of enzymatic (catalase, superoxide dismutase, glutathione peroxidase, and glutathione reductase) and non-enzymatic antioxidants like glutathione, vitamin E and C.

Finger millets for the treatment of reducing aging

The antioxidants and phenolics compound present in finger millet in greater amount which 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 (Hegde et al.,2002).

Anti-protein (glycation) property of finger millet

Polyphenols present in finger millet seed coat are effective inhibitors of fructose induced albumin glycation (Veenashri and Muralikrishna, 2011).

Inhibition of phospholipases (PL)

Gallic acid, quercitin and crude polyphenol extract from finger millet act as potent inhibitor of PLA2 from snake venom, it indicates the potential application of finger millet in treating inflammatory disorders (Chethan et al., (2008).

Natural probiotic treatment for diarrhea

Finger millet drink fermented by lactic acid bacteria used as a therapeutic agent against diarrhea (Lei et al., (2006).

CONCLUSION

Cereals and millets constitute a major component of diet consumed in developing countries. Finger millet is a staple food in different parts of word especially in Africa and India. It is considered as an extremely healthy food as it contains several health benefiting properties. It’s nutritional and functional properties have been reviewed and observed best among all other cereals grains. All the varieties of finger millet are high in calcium, potassium, and magnesium. Therefore, varieties with higher mineral composition should be utilized for dietary purposes. Processing of finger millet improves the nutritional contents, increases bioavailability of nutrients and reduces anti-nutritional factors. Finger millet is a gluten-free cereals so that it can be a good replacement of others cereals like paddy, wheat and barley etc. The calcium content of ragi is high which is useful for bone formation in children. Consumption of ragi is good for the diet of diabetic patients. It is a solution for those patients, who are suffering from high body mass index. The food products which are prepared from ragi are used in defence services and normal consumption by the people. By products of finger millet are also getting attention in industries.

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