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Millets: The Sustainable Super-Food with Anti-aging Properties

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Millets, a type of cereal from the Poaceae family, are among the earliest crops still produced today. They are a customary staple meal in the world's arid regions. It is a drought-resistant crop that needs minimal upkeep. This paper examines the possible anti-aging benefits of many millet species, including finger millet, foxtail millet, and pearl millet, as well as their diverse nutritional profiles. Rich in vital minerals like vitamin E, selenium, and amino acids, as well as antioxidants like polyphenols and flavonoids, millets assist tissue repair, improve collagen synthesis, and lessen oxidative stress on the skin. Their low glycemic index also helps to stabilize blood sugar levels, which lowers the risk of age-related illnesses including diabetes and heart disease. Additionally, millets support intestinal health, which is essential for absorbing nutrients and maintaining general vitality. Millets are an environmentally friendly crop that promotes agricultural sustainability because they demand little in the way of resources to grow. By integrating millets into the diet, individuals can benefit from a natural approach to longevity, promoting both personal health and environmental well-being.

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Keywords: Millets; sustainable super-food; anti-aging properties.

1. INTRODUCTION

“One of the first crops that are still farmed today is millets, a type of cereal from the Poaceae family. They are a routine staple meal in the world's dry regions. Millet can be grown in marginal land that needs minimal maintenance. Because of its high nutrients contains and nutrious, interest from consumers is growing. Millet is currently the sixth most important cereal grain worldwide. In India, millets account for 10% of the country's overall grain production, with an annual yield of 18 million tons of grain produced on an estimated 17 million acres” [1]. “Due to their extreme resilience, millets frequently flourish in environments where other crops would fail” [2]. “They require little water, are resistant to pests and diseases, and can withstand high temperatures, making them an ideal crop under climate change scenarios” [3].

Numerous bioactive chemicals found in millets are said to be the source of a wide range of health benefits. Furthermore, finger millet extracts included a potent radical-scavenging molecule in comparison to rice, wheat, and other millet species [4,5]. “Nonetheless, the consumption of 55% finger millet can increase the activity of antioxidant enzymes, such as glutathione reductase, catalase, and glutathione peroxidase, which have protective properties. Additionally, this can prevent the collagen from being cross-linked. Ageing is characterized by a decrease in flexibility of the skin, tendon, periodontal ligament, and fetal tissue” [6,7].

2. NUTRITIONAL COMPOSITION

“A crucial component of human health and wellbeing is the nutritional value of food. Millets are a great food source for phytochemicals and micronutrients” [10]. “Millets are a rich source of nutrients, particularly vitamins, minerals, dietary fiber, and phytochemicals, and they have a host of health advantages. Their high calcium content (0.38%), roughage or dietary fiber (18%), and phenolic compounds (0.3–3%) make them nutritionally significant. The significance of all millets varieties is indicated by the richness of phytochemicals and micronutrients with enormous therapeutic potential” [11, 12]. Table 2 present the average nutrient content of several millets.

“Millets are typically processed before being consumed in order to eliminate the parts that are inedible, increase shelf life, and enhance sensory and nutritional qualities. Basic processing techniques like dehulling, soaking, germination, roasting, drying, polishing, and milling (size reduction) are employed to get millets ready for human consumption. Concurrently, secondary or contemporary processing methods such flaking, extrusion, frying, puffing, popping, fermenting, parboiling, baking, and so on are used to create millet-based value-added processed food products” [18]. “Even if the purpose of these processing methods is to increase the digestibility and nutritional bioavailability, subsequent processing causes a significant loss of nutrients” [19].

3. HEALTH BENEFITS OF MILLET CONSUMPTION

“Millet is superior to rice and wheat in terms of its mineral composition. Compared to rice and wheat, millet has higher fiber content. The calcium content of the remaining millet is at least twice that of rice, while finger millet has thirty times the calcium content of rice. Each millet exceptionally high for wheat and rice and hence it is the solution to the malnutrition that affects the majority of the Indian population. These are abundant in B-complex vitamins, while millet is high in lecithin, protein, and whole grains. And those people are allergic; millet is the least aggressive of all grains” [20]. “Millets have a substantial amount of magnesium, which helps the body balance insulin and glucose receptors, preventing diabetes. Due to their high fiber content and alpha amylase-prevention properties, which have been shown to reduce the digestion and absorption of polymeric carbohydrates, finger millet-based diets have been associated with a low glycemic index” [21]. “Due to their high magnesium content, little millets can help reduce blood pressure and heart attack risks, especially in cases of atherosclerosis. Additionally, millets include the mineral K, which can help lower cardiovascular problems and blood pressure. With the aid of the microbiota present in the digestive tract, plant lignin found in millet can transform into animal lignans, which have been shown to be effective against certain forms of cancer and heart disease. Millets are rich in fiber, which is important for lowering blood pressure, eliminating LDL (low density lipoprotein) from the body, and increasing HDL (high density lipoprotein), which is the beneficial kind of cholesterol. In relation,

Table 1. Types of millets with some of their traits

Sl. No.	Crop Scientific	Name	Vernacular	Names Traits
1	Sorghum	*Sorghum bicolor* (L.)	Great millet, jowar, cholam, jola, jonna, durra, Egyptian millet, feterita, Guinea corn, jwari, juwar, milo, shallu, gaoliang,	Drought tolerant, excellent recovery mechanism from stresses, highly adapted to wide range of soils, altitudes and temperatures, responsive to high input management
2	Pearl millet	*Pennisetum glaucum* (L.)	Bajra, cattail, bulrush, candlestick, sanyo, munga, seno	Highly resilient to heat and drought, come up in very poor soils, but responsive to high input management
3	Finger millet	*Eleusine coracana* (L.)	Ragi, Mandua,Nagli, Kapai, Marua, Nachni, African bird's foot, rapoko, Hunsa, wimbi, bulo, telebun, koracan, kurakkan	Moderately resistant to heat, drought and humidity, adapted to wide altitude range (Up to 2100 m amsl), rich source of calcium.
4	Barnyard millet	*Echinochloa crusgalli* (L.)	Japanese, Jhingora, Kudraivali, Oodalu, sanwa, sawan, Korean, kweichou	Very short duration (Fastest growing), voluminous fodder, not limited by moisture, high altitude adapted (Up to 2700 m amsl)
5	Foxtail millet	*Setaria italica* (L.) *Setaria verticillata* (L.)	Kauni, KAngni, Korra, Tenai, Rala, Italian, German, Hungarian, Siberian, navane, thanahal Bristley foxtail millet	Adapted to low rainfall, high altitude (Up to 2000 m amsl), short duration, tolerant to low fertility and drought
6	Kodo millet	*Paspalum scrobiculatum L.*	Varagu, bastard, ditch, naraka, water couch, Indian paspalum, creeping paspalum, amu	Long duration, but very hardy, needs little rainfall, comes up in very poor soils, grown well in shallow and deep soil, good response to improved management
7	Little millet	*Panicum sumatrense*	Little millet, Kutki, Samalu, Same, samai, Blue panic, heen meneri	Short duration, adapted to low rainfall and poor soils- famine food; withstand waterlogging to some extent, Up to 2000 m amsl
8	Proso millet	*Panicum miliaceum* L. ssp. *miliaceum*	Cheena, Panivaragu, Variga, Baragu Common, hog, broom, samai, Russian, panic	Short duration, adopted to low rainfall and high altitude area, tolerant to heat and drought
9	Brown top millet	*Brachiaria ramosa* (L.)	Brown korale	Short duration, adapted to poor soils with less rainfall. Seed used as feed for game bird.
10	Fonio	*Digitaria exilis* (Kippist)	Fonio, acha, fundi, hungry rice	Shorter duration (70-150 days), adapted to poorly fertile sandy and stony soils, low rainfall

Source: [1, 8, 9]

Table 2. Proximate nutrient composition and nutritive value of various millets (g/100 g db and mg/100 g db)

Variety	Carbohy-drate (g)	Protein (g)	Fat (g)	Ash (g)	Fiber (g)	Ca (mg)	Fe (mg)	Zn (mg)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Energy (kcal)
Sorgam	71	10.4	3.1	1.8	2.0	25	5.4	3.1	0.38	0.15	4.3	329
Finger millets	59-75	6.9-10.9	1.5	2.6	15.2	350	3.9	3.13	0.42	0.19	1.1	336
Kodo Millets	72-76	11.2	3.2-4.9	3.3	5.2	35	1.7	1.9-2.4	0.15	0.09	2.0	353
Foxtail Millets	55-69	8.4	4.0	3.3	9.4	31	2.8	2.92	0.59	0.11	3.2	351
Fonio Millets	68-75	15	3.3	3.4	18.2	20	2.1	1.5	0.17	0.22	1.15	379
Little Millets	76	15	4.5	5.4	2.5	17	9.3	5.25	0.30	0.09	3.2	329
Barnyard Millets	74	11.0	5.2	4.5	13.6	22	18.6	3	0.33	0.10	4.2	300
Pearl Millets	67-72	11.8	5.1	2.2	13.8	42	11.0	3.29	0.38	0.21	2.8	363
Proso Millets	64-76	12.6	2.9-11.6	2.7	13.1	15	2.2	2.36	0.41	0.28	4.54	316

Source: *[13, 14, 15, 16, 17]*

lignin and phytochemicals in pearl millet which is act as a strong antioxidant so that it can be prevented heart related issue. Pearl millet is regarded as a heart-healthy food as a result. Finger millet and proso millets have demonstrated a notable decrease in serum free fatty acid mass" [20].

Millets have a noteworthy impact on lowering blood triglycerides, LDL cholesterol, cardiovascular disease, and lipid peroxidation [22]. It is rich source of minerals, dietary fibers, and phenolic compounds and offer health benefits such as antimicrobial, anti-diabetic, anti-cancerous, anti-artherosclerogenic effects, antioxidant, and anti-aging properties [23, 24, 25]. Finger millet is considered to have nearly the highest nutritional value of all the millets [37]. The preliminary anti-aging properties of millet grains, particularly finger millet, have also been documented in a number of recent researches [4, 26, 27]. Like whole grains, millets are high in magnesium, which is a cofactor for enzymes, particularly those involved in the uptake of glucose and the production of insulin. It has been suggested that magnesium lessens the impact of heart attacks and migraines. Millets contain hypo-cholesteremic niacin. Eating millets lowers harmful lipids and C-reactive protein, which may help avoid cardiovascular illnesses. Plenty of phosphorus is found in millets, and this mineral is crucial for determining cell structure. Phosphorus not only makes up the bone mineral matrix but is also a crucial part of adenosine triphosphate (ATP), the cell's energy currency [28].

4. ANTI-AGING AND ANTI-OXIDANT PROPERTIES OF MILLETS

"Antioxidants derived from plants, such as phenolics and flavonoids have numerous biological effects. Antioxidants play a major role in the reduction of lipid peroxidation, a process that plays a key role in cancer and aging" [29]. According to [30], "antioxidants offer persistent radical intermediates that shield fatty acids and oils from oxidation-induced damage. The millet seed coat contains polyphenols such as phenolic acids, flavonoids, and tannins that function as reducing agents, metal chelators, singlet oxygen quenchers, and free radical quenchers" [31]. As antioxidants, these substances may exhibit several health advantages, chief among them being anti-aging properties. "Millet grain is entirely edible, and conventional food recipes are prepared from wholemeals throughout Asian and African countries. This indicates that the phytochemicals of millets such as polyphenols are consumable without any adverse effects on human health" [32]. Varieties of millets are recognized for their abundance in distinct polyphenols, which have the potential to function as strong antioxidants and are essential for demonstrating anti-aging characteristics.

Recent research on the phenolics of millet grain varieties grown in South Korea, such as finger Italian millet (FIM), barnyard millet (BM), Italian millet (IM), and millet (M), has demonstrated their strong antioxidant potential and anti-glycemic qualities that are beneficial against diabetes mellitus, a major age-related condition. The main causes of chronic diseases like diabetes, heart disease, cancer, cataracts, and aging are excessive creation of free radicals and lipid peroxidation. One of the main causes of diabetes and aging issues is nonenzymatic glycosylation, a chemical process that takes place between the amino group of proteins and the aldehyde group of reducing sugar [33]. Free radicals cause collagen to undergo non-enzymatic glycosylation and cross-linking, while polyphenols and other free radical scavengers prevent these processes [34]. Recently, [35] noted that several types of millets grown in Sri Lanka, including finger millet, proso millet, white finger millet, kodo millet, and foxtail millet, had antidiabetic qualities. These millets are an essential functional food for slowing down the aging process because they block early glycation, intermediate glycation, and the reversal of antiglycated products in diabetics.

Diabetes, heart disease, stroke, mental illness, some cancers in people, and the oxidation of biological components by oxygen- and nitrogen-reactive species are all linked to a number of prevalent diseases. As antioxidants, many phytochemicals guard against oxidative damage and preserve appropriate physical stability. Nutritionists, medical professionals, and consumers have long been interested in food plant polyphenols because of their potential health benefits, which include lowering the risk of diabetes, aging, neurodegenerative and cardiovascular diseases, cancer, and numerous infections [36]. India is the home of Kodo millet, finger millet, small millet, sorghum, and fox millet, as well as white variations of these millet types such Free Radical Demolition Off (DPPH) 2,2-dip electron. [7] used paramagnetic resonance (EPR) to measure -L-Picrilhydrozyle. Therefore, antioxidants and plantbased phytochemicals are two especially nutraceutical constituents which have substantial anti-carcinogenic properties which take action as destroyer for singlet oxygen species and free radicals [37]. Research indicating that a key dietary component influences aging and related age-related disorders has grown significantly in the last few decades. Numerous elements make up these dietary components, such as fiber for lowering blood sugar levels in diabetics, fruits and vegetables for preventing heart disease, specific fats (trans, polyunsaturated, and saturated) for preventing heart disease, calcium and vitamin D for preventing osteoporosis and bone fractures, and many more [38].

Varieties of millets are recognized for their abundance in distinct polyphenols, which have the potential to function as strong antioxidants and are essential for demonstrating anti-aging characteristics [32]. Dimers and trimers of ferulates, for instance, are found in many varieties of millet grains and have comparatively stronger antioxidant activity. Because they contain higher concentrations of phenolic compounds, tannins, and flavonoids than the white variety, colored finger millet varieties from the Northern Malawi region (brown, reddish, or red) have more notable antioxidant action [39]. Defatted foxtail millet (DFMB) has high antioxidant effectiveness and can scavenge superoxide anions and free radicals [40]. Millets have potential as a nutraceutical and functional food ingredient that promotes health and lowers the risk of disease because they are a rich natural source of antioxidants. However, this review has demonstrated how millet functions as an antioxidant scavenger in the body, potentially reducing oxidative stress.

5. CONCLUSION

Millets are a promising sustainable super-food because of their anti-aging and health-promoting properties. It is rich in vital nutrients like fiber, vitamins, minerals, and antioxidants. They also have many other health benefits, such as lowering oxidative stress, promoting healthy skin, and supporting cardiovascular and metabolic processes. Various natural compounds derived from various plants have also been shown to prevent aging and related diseases. Moreover, their ability to withstand extreme climate conditions and minimal water needs renders them an environmentally sustainable crop that holds significant potential in mitigating food security issues in the context of climate change. The use of millets has many health benefits. A balanced diet with defined nutritional supplements plays a crucial part in promoting the lifespan and health of human beings. This review highlights millets' potential as a sustainable agricultural solution in addition to being a nutrient-dense food. Therefore, encouraging millets to be grown and eaten can help create a more sustainable food system and healthier aging process.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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