

Foxtail Millet – Nutritive, Health and Value-Addition Properties - A Review

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ABSTRACT

Millet is consumed as a staple food, particularly in developing countries, as part of the traditional diet and is gaining popularity throughout the world. They are a source of valuable dietary energy, with high caloric value. Several bioactive compounds are found in higher quantities in millets compared to other staple cereals. The present review explores different spectra of the foxtail millet, from biochemistry, microbial and nutrition to human health promotion. Additionally, foxtail protein or its hydrolysate has demonstrated a number of bioactive effects that warrant further investigation for the treatment of human chronic illnesses. In terms of human nutrition, it has great promise for effectively creating affordable, functional and value added food items that aid in the management of malnutrition. Finally, we examine a variety of millets' products that can enhance societal nutrition through the prism of value-addition. Applications for millet products can be found in the food, pharmaceutical, bio-based, and agricultural industries. The background material together serves as the justification for this review.

Keywords: Millet, anti-nutritive; oryzenol, arabinoxylans; hydroxyperoxides; kunun

1. INTRODUCTION

Millets are small-seeded, minor cereals of the Poaceae family of grasses (Kheya et al., 2023). They are grown year-round in the semi-arid tropics of Asia and Africa, have a short growth season, are resistant to pests and diseases, and can withstand drought. Among these, foxtail millet is one of the small millets that dates back to 6000 B.C. in China. Foxtail millet has been grown historically amid drought conditions since the Indus Valley culture. The significance of millets is highlighted in the Vedic literature. Additionally, research suggests that in the ninth century, the Chola dynasty used foxtail millet (Diao and Jia 2017). The yellow kind of foxtail millet is regarded as the best grain in Ayurveda (Jacob et al., 2024). It ranks second in terms of total millets produced and sixth in terms of grain crops farmed worldwide. In Central Asia, the crop is mostly utilized as fodder for livestock and birds (Pawar et al., 2022). The Food and Agriculture Organization (FAO) celebrated 2023 as the 'International Year of Millets.' (FAO). India celebrated 2018 as 'The Year of Millets.' The National Nutrition Monitoring Bureau (NNMB) under the aegis of National Institute of Nutrition (NIN) has reported that the consumption of millets is higher in the states of Gujarat (pearl millet), Karnataka (finger millet), and Maharashtra (sorghum), whereas it is negligible in the states of Kerala, Orissa, West Bengal, and Tamil

Nadu (NIN).

Because of its physico-chemical characteristics, research studies suggest that foxtail millet has superior nutritional profiles. Millets would thereby improve food quality, nutrition, and economic value when used to make ready-to-eat, ready-to-cook, and ready-to-serve items (Rao et al., 2017). More functional foods, such as probiotics, nutraceuticals, and fermented meals enhanced with protein and fortified with millet, have been developed globally in the past decade (Kola et al., 2020). The rationale behind these research goals are the special blend of macro and micronutrients. Also, it is low in fat yet high in minerals, fiber and protein content. A range of health benefits such as antioxidant, anti-celiac disease properties, anti-diabetic and inflammatory is attributed to millets (Khan et al., 2025). Several nations throughout the world are currently investigating the possible use of foxtail millet grains in food product formulations, particularly as a functional ingredient that can support the development of health status and consumption habits (Ramashia 2025; Zhang et al., 2023). Before beginning these efforts, a review of the existing knowledge will aid fill the gaps and aid research in several aspects of millets such as physico-chemically, optimizing processing processes, identify bioactive compounds with diverse health ameliorative properties, dietary qualities essential for designing value-added products and ready-to-eat products. In the following sections we summarize several aspects of the millet covering literature of potential importance for millet in value-addition to food security, nutrition and health.

2. NUTRITIONAL COMPOSITION

Sorghum and millets have similar basic anatomical features and structures. The pericarp (outside covering), endosperm (starchy part), and germ (oily part) are the important major structural components. Common in foxtail millet, the pericarp is only loosely connected to the endosperm. The pericarp easily breaks away in the case of utricle-type kernels, leaving the seed coat to uncover the inner endosperm (Sapna et al., 2019). According to Bandyopadhyay et al. (2017) and Sharma and Niranjana (2017), foxtail millet is high in fiber (60.9%), proteins (12.3%), amino acids, minerals (3.3%), vitamins (VB1, 0.59 mg/100 g; VB2, 0.11 mg/100 g; VB3, 3.20 mg/100 g; VB5, 0.82 mg/100 g), and antioxidant compounds. Foxtail millet and corn have comparable amino acid compositions; it has comparatively high levels of glutamic acid, alanine, aspartic acid, leucine, methionine, and lysine (Moharil et al., 2019). Table 1 and 2 summarize the nutritive and dietary fibre content of millets in comparison to wheat and rice. The cereal has been underutilized since long with recent trend indicating advanced research into the bioactive and nutritional aspects. However, with planned scientific research and planning at several levels to specific aims has the ability to aid the world's ever-increasing population with its nutritional and health promoting effects. In terms of nutritional components it considerably outperforms other commonly consumed cereals like wheat and rice. In addition to be a valuable source of nutrition among other cereal grains, foxtail millet has a wide variety of health beneficial components. On comparing it with other millets it is found that apart from higher protein content, it also contains higher number of essential amino acids and sulfur-containing amino acids, including methionine, and cysteine. In comparison to the most popular cereal grains, such as rice and wheat, foxtail millet flour has a resistant starch content that which is considered outstanding for diabetic individuals. The foxtail millet oil and its fatty acid profile implicate its potential as a natural oil rich in linoleic acid and tocopherols. Another important observation in the higher calorie and high fiber content

which is a major requirement in nutritional supplement programs. The macro and micronutrients ratios are determinants of the physico-chemical properties of millet and the stability and attributes have a major role in the food processing and value addition chain.

The majority of the bioactive substances found in foxtail millet include carotenoids, bioactive peptides, and phenolics. In addition to these substances, oryzenol and tocopherol are chemicals which promote health. Dietary fiber, proteins and amino acids, minerals, sterols, phytic acid, and unsaturated fatty acids are other bioactive substances (John and Valerie 2022). Tryptophan-0.99, threonine-3.10, isoleucine-7.60, leucine-16.06, lysine-2.10, methionine-2.80, phenylalanine-6.70, valine-6.90, arginine-3.60, and histidine-2.10 are among the amino acids that include sulfur (Gurupavithra et al., 2013). Nutri-millet is an abundant source of essential macro- and micronutrients, such as carbohydrates, protein, dietary fiber, lipids, and phytochemicals (Gowda et al., 2022; Benhur 2016). Further estimation and understanding of the roles of millets in growth in a wider range of diets is important to develop appropriate dietary programs and improve the nutritional status of various age groups. Major micronutrients in foxtail millet reported by researchers are based on germplasm collection and diversity. They include Iron (3.69 to 7.51 mg/100g), zinc (4.54 to 5.71 mg/100 g), calcium (13.13 to 39.58 mg/100 g), potassium (219.43 to 349.47 mg/100), copper (0.60 to 1.09 mg/100 g), and manganese (1.05 to 1.64 mg/100 g). Sathisha et al., (2020) report on genotype-specific higher zinc and iron content (26.21 and 721 ppm). Millets are treated using both conventional and cutting-edge methods to increase their bioavailability and reduce their anti-nutritional characteristics (Tanwar et al., 2025). Additionally, several researchers have effectively demonstrated the benefits of using millet as a staple to enhance nutrition for people of all ages. Swathi et al., (2016) describe a reasonably priced malted blend of different millet that enhances the nutritional status of expectant and nursing mothers. Next, (Gautam et al., 2015) report the use of home made extrusion cooking to create ready-to-eat snack products that are high in micronutrients and have acceptable sensory qualities for malnourished children. As reviewed by Anita et al., 2022 the nutritional characteristics and processing of Indian millets are significantly influenced by the processing techniques. The results implicate germination and fermentation has a positive improvement in the overall nutritional characteristics of millets, whereas excessive dehulling, polishing, and milling resulted in a reduction on of the dietary fiber and micronutrients. A considerable variation in the content of nutrients and antinutrients was found among the milling fractions, such as nutrient composition, antinutritional factors and flour functionality (Devishetti 2014).

Table 1. Nutritional content of various millets in comparison to wheat and rice/gm (Ref: IFCT book 2017, Jacob et al., 2024)

Nutrient	Foxtail millet	Finger Millet	Pearl Millet	Little Millet	Rice	Wheat
Carbohydrate (g/100g)	60.09	66.82±0.73	61.78±0.85	65.55±1.29	78.24±1.07	64.72±1.74.
Crude Protein (g/100g)	12.30	7.16±0.63	10.96±0.26	10.13±0.45	7.94±0.58	10.59±0.60
Crude fat (g/100g)	4.30	1.92±0.14	5.43±0.64	3.89±0.35	0.52±0.05	1.47±0.05

Crude fiber(g/100g)	8.00	11.187±1.14	11.49±0.62	7.72±0.92	2.81±0.42	11.23±0.77
Ash(g/100g)	2.3	2.04±0.34	1.37±0.17	1.34±0.16	0.56±0.08	1.42±0.19
Energy(K.J/100g)	1383.58	1342±10	1456±18	1449±19	1491±15	1347±23
Calcium(mg/100g)	31	364±58	27.35±2.16	16.06±1.54	7.49±1.26	39.36±5.65
Iron(mg/100g)	2.8	4.62±0.36	6.42±1.04	1.26±0.44	0.65±0.11	3.97±0.78

Table2.Dietary Fiber composition of different types of millets(Ref:IFCTbook2017,Jacob et.al., 2017)

Milletvariety	Fibercontent(g/100g)	Fibertypeandcomposition (approximate g/100g)	
		InSolubleDF*	SolubleDF*
Sorghum	10.22±0.49	8.49±0.40	1.73±0.40
PearlMillet	11.49±0.62	9.14±0.58	2.34±0.42
FingerMillet	11.187±1.14	9.51±0.65	1.67±0.55
FoxtailMillet	8.00	-	-
KodoMillet	6.39±0.60	4.29±0.82	2.11±0.34
LittleMillet	7.72±0.92	5.45±0.48	2.27±0.52
BarnyardMillet	6.00	-	-

3. MICROBIAL ANALYSIS, MICROBIAL BIOPROCESSING, AND VALUE ADDITION

A connection between the food microbiome and health advantages is established by the relationship between microbial diversity and product attributes. Lactic acid bacteria such as Streptococcus, Leuconostoc, and Lactobacillus are among the species that have been identified from millet. The fungi were Penicillium, Aspergillus, Trichoderma, Candida, and Saccharomyces, and the other bacteria were Staphylococcus, Bacillus, and Pseudomonas (Aboabaa and Osuntogun 2004). Lactic acid bacteria are the predominant microbiota in fermented millet products. Lactobacillus paracasei was used in Issoufua solid-state bioprocessing of foxtail millet to create fermented foxtail millet meal with extra healthy ingredients (Amadou's et al., 2013). The findings suggest that the product has promise for biological value addition in the food industry and is an effective antioxidant and antibacterial. Another study found that fermentation using Pleurotus geesteranus significantly improved the antioxidant qualities and phenolic component concentrations (Lin et al., 2024). There are presently value-added products made from foxtail millet, like soft probiotic ice cream that has a ten-day shelf life and a viable count of Lactobacillus helveticus bacteria (Sangma and Mishra 2017). Foxtail millet probiotic drinks made with a combination of lactic acid bacteria (Lactobacillus acidophilus MTCC 10307) and probiotic yeast (Saccharomyces boulardii) have been reported (Fatima 2019). Firmicutes is the predominant phylum in the dough, as evidenced by the diversity and metagenomics potential of the bacterial population examined during dough fermentation. In contrast, the most prevalent bacteria were heterofermentative lactic acid bacteria, such as Companilactobacillus, Limosilactobacillus, Pediococcus, and Lactobacillus. Finally, Proteobacteria were gradually inhibited after fermentation, and Companilactobacillus crustorum was notably found abundant during dough leavening (Liu et al., 2024).

4. BIOACTIVE COMPOUNDS AND HUMAN HEALTH

Millets stand out from other cereals due to their high protein, dietary fiber, calcium, and polyphenol content (Kothapalli et al., 2024). Preventing diverse diseases including diabetes, cataract development, and cardiovascular disorders is one of the health-promoting benefits. The chemicals that scavenge free radicals in cells are called antioxidants. Many foods, including grains, fruits, vegetables, spices, and herbs, are rich in antioxidants (Rahman et al., 2023). By scavenging free radicals, antioxidants improve health. Millets are a nutrient-rich food that is advised for the health and wellbeing of people of all ages, including newborns, nursing mothers, the elderly, convalescents, and the elderly (Kimeera and Sucharita 2019; Vijayarani et al. 2017). Millets are high in flavonoids and total phenols, according to biochemical studies. 50% ethanol extract from DFMB promotes phenolic molecules with significant antioxidant activity (Amadou et al., 2011). The findings showed that fermented foxtail millet meal can be used to produce natural antioxidants, antibacterial activity, and enzyme resistance. Processing, addition, and cooking effects show that foxtail millet has a great capacity to scavenge radicals. There is a correlation between the samples' high levels of natural antioxidants like phenolic compounds, cinnamic acid, and phytic acid antioxidant activity recommending that cooked foxtail millet be consumed by humans. In cancer biology, in vitro research suggests that millet phenolics may be useful in halting the development and spread of cancers (Chandrasekara & Shahidi, 2011). The ability of foxtail millet phytochemical components to inhibit the proliferation of breast cancer cells is demonstrated by (Kurubara et al., 2022). Through increased ROS generation, polyphenolics induce apoptosis in human colorectal cancer cells and naked mice (Shi et al., 2015). According to the findings of the animal experiment, millet bran peptides reduce inflammation in spontaneously hypertensive rats (SHRs) in inflammatory illnesses (He et al., 2022). Moreover, protein hydrolysates, particularly those that are raw or extruded, reduce hypertension and cardiovascular disorders (Chen et al., 2017). According to studies on lifestyle disorders, the anti-diabetic impact is linked to changes in the makeup of the gut microbiota and the serum metabolomics profile (Jiang et al., 2024). Finger millet efficiently lowers postprandial blood glucose levels by inhibiting starch-digesting enzymes such as α -glucosidase and salivary and pancreatic amylases (Shobana 2010). By inhibiting hepatic gluconeogenesis, the ethanolic extract of foxtail millet produced a hypoglycemic effect in diabetic rats in comparison to anti-diabetic medicine (Qi 2019).

Including millet in the diet enhances nutrition in general and intestinal health in particular. β -glucan, arabinoxylan, and non-starchy polysaccharides provide up to 15–25% of millet's dietary fiber content (Izydorczyk and Dexter 2008). Regular bowel motion is enhanced by insoluble particles like cellulose and hemicellulose. Additionally, soluble fibers, such as pectins, arabinoxylans, and beta-glucans, have the ability to form gels and have a variety of physiological consequences, including raising food viscosity and preventing the absorption of macronutrients by absorbing water (Khouri et al., 2011). Frequent intake of millet fiber has been associated with better nutritional absorption, better gastrointestinal function, and a lower risk of developing a number of digestive problems (Maurya et al., 2023). In rats, consuming foxtail millet was reported to reduce colonic inflammation and the risk of colitis-associated colorectal cancer (CRC) caused by AOM/DSS (Zhang B et al., 2022). Through the immune system and the synthesis of neuroactive substances like neurotransmitters, which can affect behavior and brain function, gut microbes interact with the central nervous system. Fermentation in the

colon produces butyrate, which can penetrate the blood-brain barrier and have neuroprotective effects, supporting brain health and perhaps affecting behavior and mood (Kim and Shim 2022). The therapeutic potential of dietary millet fiber interventions in illnesses like anxiety, depression, and neurodegenerative disorders is being investigated in preclinical and clinical investigations.

5. PROCESSING AND VALUE-ADDITION

According to Chandrasekar and Shahidi(2011), foxtail millet phytochemical compounds function as metal chelating agents, reducing agents, radical quenchers, and free radical scavengers by inhibiting the production of reactive oxygen species (ROS), hydroxyperoxides, and singlet oxygen molecules. However, due to phenol-protein interactions and metal chelation, these bioactive substances—which include polyphenols, tannins, saponins, phytates, and other substances—also known as anti-nutritional factors, impair the digestibility of proteins and starches and decrease the bioavailability of minerals (Dar and Singh, 2021). Grain biological processing increases the quantity of specific phenolic acids and flavonoids, improving the antioxidant capacity and bioactivity while also significantly lowering anti-nutritional components (Asensio-Grau et al., 2020; Balyatanda et al., 2024). Enzyme activation during grain germination speeds up the breakdown of protein, starch, and cell wall components, increasing nutritional digestibility and releasing bound polyphenols. Furthermore, because of increased hydrolytic activity, the microbial enzymes produced during fermentation have an impact on the physico-chemical profile and macromolecular arrangement (Huang and Chou, 2013). Soaking has also been shown to decrease a number of anti-nutritional elements brought on by leaching loss in steep water (Sarma and Sarma 2017). Researchers have documented a number of variable alterations following bioprocessing. Higher enzymatic activity, improved in vitro carbohydrate and protein digestibility, a decrease in antinutrients, and an improvement in the bioactive profile are reported by Sharma and Sharma (2022). In a different study, (Nazni and Shobana Devi 2016) show notable differences in the pasting, nutritional, anti-nutritional, and functional qualities of two chosen millets in response to various processing techniques. Due to its lack of gluten, foxtail millet has poor processing qualities, which limits the creation of foxtail millet products. In addition to the previously described techniques, research has shown that microbial fermentation, extrusion, heat-moisture treatment, and superfine grinding are effective ways to enhance the processing properties of foxtail millet. Granule size variation in degrees, amorphicity, and crystal structure of millet starch granules are among the alterations reported by Tongshuai Yan et al., (2022). As for millet starch properties, the methods improved the digestibility, increased the content of resistant starch, and reduced the content of short-chain starch.

6. NUTRITIVE VALUE AND AMELIORATIVE BENEFITS OF FOXTAIL MILLET ON HEALTH

Functional foods offer health benefits that extend beyond their nutritional value and contain supplements or other additional ingredients (Essa et al., 2022). Presently, millets are fortified with vitamins, minerals, probiotics, and fiber. The inclusion of phenolic substances, including phytosterols, lignins, polyphenols, phytocyanins, and phytoestrogens, in addition to core nutrients, endows millets these medicinal properties (Malathi et al., 2023). By acting as antioxidants, these substances guard against damage to the cell's genetic material or membranes. A healthy lipid profile is maintained by the high levels of stearic and linoleic acids found in foxtail millet (Gowda et al., 2022). Total phenolic contents (TPC) are higher

in hulls, and millet grains' antioxidant qualities have been shown to decrease upon dehulling (Kumari et al., 2016). Millet phenolics prevent protein glycation, lessen the formation of protein aggregates, and guard against oxidative DNA damage and hydroxyl radical-induced protein fragmentation (Anis and Sreerama2020). Because of its high dietary fiber content, resistant starch, vitamins, minerals, and essential amino acids—aside from lysine and methionine—foxtail millet is more nutritious than other major grains like wheat and rice. According to Gopalan et al. (2017), foxtail millet has the following nutritional values per 100 g: protein (8.92g), fat (2.55g), minerals (1.72g), fiber (6.39g), carbs (66.19 g), and calories (331 kcal). In addition to possessing higher TPC (total phenolic content) and TFC (total flavonoid content) than other millets, finger millets also prevented glycation and collagen cross-linking. Health benefits of foxtail millet include that it can be used by people suffering from celiac disease because it doesn't contain gluten, and it helps to reduce diabetes, weight loss, and heart disease because of the complex carbohydrates and resistant starch present in it (ojha and srivatsava 2023). Magnesium present in it helps to reduce migraine and heart attack (Volpe 2013), niacin reduces cholesterol level, and phosphorous helps with fat metabolism and tissue repair (Romani et al., 2019).

7. FUNCTIONAL FOODS AND THEIR APPLICATIONS

Among the many benefits of foxtail millet are the instant ready-to-eat (RTE) convenience products, which are preferred over laborious fermentation, processing, and other time-consuming procedures (Joshi et al., 2023). Value-added products made from foxtail millet are low in calories, gluten-free, high in phenolic compounds, slow down digestion by causing satiety, and lower oxidative stress (Goudar et al., 2023). Key value-added products from foxtail millet include puffs, extruded goods, flakes, biscuits, bread, cakes, and pizza bases (Palani 2023). This value addition for foxtail millet will raise awareness among the public, which will benefit farmers and boost the general population's use of the grain. Beverages and confections are the most popular value added products (Masoodi 2024). Any liquid food that satisfies thirst and revitalizes the body and mind is called a beverage. The primary characteristic of a beverage is its high water content. They are divided into two general categories: alcoholic and non-alcoholic. Alcoholic drinks include things like wine, whiskey, brandy, cider, sake, and neera. Tea, coffee, whey beverages, and fruit beverages (e.g., RTS, squash, nectar, cordial, and syrup) are examples of non-alcoholic beverages. The 19th century saw the beginning of the confectionery arts in India. Indian confections can be divided into flour-based, Mithai, Khoa, Channa, and other types (Aggarwal et al., 2018). One of the traditional dishes made in several regions of India is laddu. A number of researchers have shown how millet flours can be used to create a wide range of goods with added value. Noodle with higher nutritional level is reported by Meherunnahar et al. (2023). Negi et al., (2021) report optimization of instant millet-based khichdi and Paniyaram (Khan & Premam, 2017). Finally, Subbaiyan et al., (2024) report probioticated foxtail millet laddu. Research has documented the use of millet additions for food and beverage fortification (Chetan Kumar et al. 2022). Millets that are high in bioactive antioxidant components which can be added to fruit beverages in place of sugar. FOS and sucralose can then be used to create a low-calorie, high-nutrient beverage. RTS (ready-to-serve) pomegranate beverage with foxtail addition is reported by Pushpa et al. (2023). From school children to the community, the value-added food items made from millets are practical and affordable solutions for enhancing livelihoods and nutrition security at many societal levels. Accordingly, school children who regularly ate a prepared multi-millet health mix showed a significant increase in height, weight, and

hemoglobin level (Durairaj et al., 2019; Anita et al., 2022; Mazumder et al., 2024). Value-based products differ from one nation to another also differ by geography, and eating patterns. Chinese, German, and Russian cuisines all use millet porridge as a classic dish. According to Adejuyitan et al., 2008 kunun is a traditional beverage in Nigeria. Value addition techniques applied to traditional foods can transform them into diverse and appealing products contributing to consumer acceptance, and cross regional barriers and enable nutritional and economic development and food security (Michel et al., 2024). Depending on the sociocultural mindset and raw material availability, each nation has its own native culinary products. Many traditional and indigenous food products can be found in India's complex sociolinguistic tapestry (Ananthanarayan et al., 2019). According to researchers, a wide variety of value-added products that are popular throughout India include anything from traditional daily-consumption recipes and bakery goods to beverages and sweets. Research data indicate foxtail millets available additive to wards this end. Sudha et al. Report millet laddus, and Vidya et al., 2004 report millet papads. Haalbai is a traditional food (sweet cake) of Karnataka, a sweet cake generally prepared from rice. The advantage of jaggery used in haalbai, prepared from natural sugars, enables consumption for people with high sugar levels. Thus traditional foods have served as a range of ready to eat, value added products such as sweets and savior, beverages and several others. Further, they have potential to maintain health, well-being and simple, cost-effective easy supplements of nutrition.

8. DISCUSSION

Food quality has alarmingly declined over the past 50 years, and critical fruits, vegetables, and food crops have lost a wide range of nutritionally important minerals and nutraceutical chemicals. The use of high-yielding cultivars and crops, the chaotic global mineral nutrient applications, the transition from natural to chemical farming, and low-nutritious cultivars and crops have all been blamed for the deterioration in food nutritional quality. Lastly, the widespread declines in the nutritional value may be caused by naturally occurring or artificially increased carbon dioxide (Bhardwaj et al., 2024). Small-seeded grasses called millets are becoming more popular due to their nutritional value and health advantages. When compared to other major grains like wheat and rice, foxtail millet may be more nutritious because of its high dietary fiber content, resistant starch, vitamins, minerals, and essential amino acids—aside from lysine and methionine (Saleem et al., 2023). It also has a high stearic and linoleic acid content, which contributes to a healthy lipid profile (Nange gowda et al., 2022). It has been demonstrated that eating millets improves health outcomes and provides a balanced nutritional profile. Gluten helps patients with a variety of health conditions, including celiac disease (Jnawali et al., 2016). It has medicinal uses in lifestyle disorders like diabetes, heart disease, and weight loss due to the complex carbs and resistant starch it contains (Zong et al., 2018). Phosphorus aids in tissue regeneration and fat metabolism and magnesium content lowers the risk of heart attacks and migraines. Finally, millets are said to have antibacterial (Kamboj et al., 2025), immunomodulatory (Rajesh et al., 2024), antiplatelet aggregation (Shivaiah et al., 2020), and inhibitory effects on digestive enzymes and cataract formation (Pradeep and Sreerama 2015), among other defensive qualities. Millets have the ability to support diversity and offer affordable food and nutrition security (Kumar et al., 2024). Population studies of the impact and acceptability of small-scale and short-term intervention indicate the potential of Smart Food products made from millets in filling the nutrition gap arising from the traditional food consumption habits in the dry zones of Myanmar (Anitha S et al., 2020). The extensive and varied applications of millet are indicated by the study results supporting various value-added products and

RTS products of foxtail millets from traditional cuisines, bakeries, beverages, sweets, and confections. The spectrum exhibits diversity increased acceptance, and use in a range of age groups and culturally heterogeneous societies. Together, these study findings demonstrate the enormous potential of millet as a human nutraceutical.

9. CONCLUSION

Foxtail millet has gained popularity as a nutritious supplement in bio fortification programs and as ingredient in various value-added and ready to eat foods. With several layers of research on the cereal starting from biochemistry, nutrition, cellular and genetics to value added foods. Each of the areas have a cascading effect starting from physico-chemical to bioactive and their stability post-production of value addition. Hence, it becomes imperative to regularly review the existing knowledge from research, epidemiology to design of fortification foods for nutrition. Newer bioactive compounds will have to be identified with the help of physico-chemical analysis, in vitro and in vivo studies and additional systematic epidemiology to integrate the foxtail millet- “treasure trove” to human nutrition. Foxtail millet and other millets have several desirable characters including hardiness, shorter growing cycle, tolerance to drought and agro climatic conditions. These traits make them favorable crops in view of the imminent threat of climate change. Additionally the nutritional and health promotion bioactive components are well suited to the global efforts to enable achieving food security. Further with its higher bio-accessibility and bioavailability properties it could be integrated to the food supply and consumption starting from grass-root, to malnourished low economical regions of the world to health conscious societies. Finally, the investigation of various goods for society will be made possible by process applications and engineering principles used in processing and value addition of millet products.

DISCLAIMER(ARTIFICIALINTELLIGENCE)

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 writing or editing of this manuscript.

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