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REVIEW ARTICLE

The Potential of Foxtail Millet as a Carbohydrate-Based Indonesian Local Functional Food

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A B S T R A C T

Foxtail millet (*Setaria italica L.*) is a round-shaped cereal grain varied in colors and sizes and is part of the *Poaceae* family alongside sorghum and maize. It is one of the most extensively cultivated crops in Asia and Africa, as well as in several other developing countries, accounting for 95% of the total global yield. This cereal grain is a good source of bioactive compounds, such as fiber and minerals, which are pivotal for maintaining human body hormone growth and blood sugar control. As a whole, the inverse relationship between blood pressure and the nutritional content of their compounds has possessed numerous health benefits, especially as an antioxidant source to lower inflammation. In animals, foxtail millet has also been proven to be safe and its benefit has been proven, specifically in terms of its gastroprotective effect. However, foxtail millet might cause an allergic reaction in humans due to cross-reactivity among different grains, whereas its safety and efficacy should be studied further. Given its favorable function in its mineral and fiber content, it may also be integrated into the food industry, such as in flour production.

K E Y W O R D S

Foxtail millet, functional food, carbohydrate-based functional food, local sources

H I G H L I G H T S

- Foxtail millet is a good local source of bioactive compounds including macronutrients and micronutrients.
- Foxtail millet gives health benefits including gastroprotective effects, cancer prevention, inflammation prevention, and anti-hyperglycemic effects.
- The safety of foxtail millet should be controlled to prevent allergic and toxic reactions
- Foxtail millet can be incorporated into flour to enhance the bioavailability and accessibility of the ingredient to consumers.

INTRODUCTION

Foxtail millet (*Setaria italica L.*) also known as Jewawut in Indonesia is an annular cereal grain varied in sizes and colors and is part of the *Poaceae* family alongside maize and sorghum. It is considered the most extensively cultivated crop in Asia and Africa, as well as in several other developing countries, primarily used as bird feed (Sharma & Niranjan, 2018). In 2014 alone, Asia and Africa produced 95% of the total global foxtail millet yield. Currently, foxtail millet is cultivated in over 26 countries with normal non-pesticide production practices, easing its classification as an organic farming-derived product (Singh et al., 2017). In Indonesia, foxtail millet was specifically distributed across several regions, including Sulawesi, Java, South Sumatra, Kalimantan, a small part of the Sunda Islands, Maluku, and Papua, dating back to the early 1900s (Jadid et al., 2022). It could also be grown in a glass house with over 100 plants per square meter density, which makes it appropriate for research purposes. For this reason, this crop has been used as a model crop to study the genomics and genetics of other millet varieties, non-millets, as well as biofuel crops. It is also practical to use as materials to understand the physiology, genome evolution, and plant architecture of bioenergy gas (Hariprasanna, 2016).

Morphologically, the grains are covered in layers of bran and husk. The husk layer itself could form up to 13.5% (w/w) of the grain, meanwhile the bran forms up to 1.5-2% (w/w) of the grain (Sachdev et al., 2021). From planting to flowering, foxtail millets take up approximately 5-8 weeks, with an additional 8-15 weeks of maturation time before they can produce plenty of seeds (Diao & Jia, 2017). In terms of nutritional value, foxtail millet is an abundant source of crude fiber that could be used to aid the human digestive system. Other than that, there is a considerable amount of other nutritional components in foxtail millet, such as protein, starch, minerals, and vitamins (He et al., 2015). However, even with those nourishment substances, foxtail millet is still considered extremely underutilized as its current utilization only focuses on poorer communities. In the wealthier communities, these grains' only uses are for bird feed and fodder. Only in several communities such as on Buru Island, foxtail millet is considered as the local food. This is unfortunate because foxtail millet could be implemented to alleviate current malnutrition issues at an affordable cost (Niu & Ge, 2018). Despite this, studies regarding the potential of foxtail millet as a local functional food are still limited. A literature review is necessary to do an in-depth analysis of its nutritional benefits and potential as Indonesian local food, which are not been thoroughly investigated and known by many people. Hence, this paper aims to examine the feasibility of foxtail millet as an Indonesian-based carbohydrate-based functional food.

BIOACTIVE COMPOUNDS

Foxtail Millet is a cereal grain that contains many essential nutrients and bioactive compounds. These grains are a good source of bioactive compounds such as minerals, phenolic compounds, amino acids, dietary fibers, carotenoids, sterols, unsaturated fatty acids, phytic acids, tools, and anti-nutritive compounds (Hutabarat & Bowie, 2022). According to Kola et al. (2020), the common minerals that were contained in foxtail millet were calcium, potassium, iron, manganese, zinc, and copper for approximately 13.13 – 39.58, 219.43 – 349.47, 219.43 – 349.47, 3.69 – 7.51, 1.05 – 1.64, 4.54 – 5.71, and 0.60 – 1.09 mg/100 g which is considered as an essential mineral that provides a lot of health benefits towards human body such as supporting a healthy immune system, growth, and control blood pressure. Aside from that, foxtail millet also contains several phenolic compounds which account for about 45.67 mg (GAE)/100 g sample, and total flavonoid which accounts for 30.52–43.96 mg RU/g sample. These compounds are known to work as an antitumor, antimicrobial, anti-inflammatory, and anti-diabetic activity (Taofiq et al., 2017; Sharma et al., 2015).

Foxtail millet contains all essential amino acids which are isoleucine, leucine, lysine, methionine, phenylalanine, threonine, valine, and histidine. These minerals are essential, mainly rich in leucine for

approximately 1040 mg/g of proteins (Sasi et al., 2023). Apart from the essential amino acids, foxtail millet also contains all non-essential amino acids which are mainly rich in glutamic acid. Leucine itself is very beneficial for the human body in terms of muscle growth, production of human growth hormone, and control of blood sugar (Rehman et al., 2023). Glutamic acid is an amino acid that is used to form proteins that have a lot of health benefits such as the immune system (Cruzat et al., 2018). When compared to the main types of millet, it has a larger protein content as well as a higher concentration of sulfur-containing amino acids, such as cysteine and methionine, and essential amino acids. Furthermore, compared to the most common cereal grains, including wheat and rice, foxtail millet flour has a starch content that is between 13% and 15%, which is considered a beneficial amount for people with diabetes (Yin et al., 2019).

Dietary fibers are one of the most known bioactive compounds contained in foxtail millet. Foxtail millet contains approximately 19.1% dietary fiber (Arora et al., 2023). Dietary fiber itself is important for maintaining the digestive system healthy and helps to regulate blood sugar (Cruzat et al., 2018). For the carotenoids, the amount of carotenoids contained in foxtail millet ranged from approximately 189.1 µg/100 mg to 201.3 µg/100 mg, which is 201.3 to 1.7 times higher compared to other grains. This led to the conclusion that foxtail millet is a good source of carotenoids which is beneficial as an antioxidant in the human body (Li et al., 2022). In terms of phytic acids, foxtail millet contains approximately PS-4 variety at a low of 5.4 mg/g and SIA-3126 variation at a high of 9.9 mg/g. Phytic acid itself may have a strong antioxidant effect in seed preservation by suppressing iron-catalyzed oxidative processes through the formation of a special iron chelate (Gupta et al., 2015). Moreover, foxtail millet is high in unsaturated fatty acids, with oleic acid (12–17%) and linoleic acid (65–69%) constituting the majority of its UFAs and accounting for over 80% of its lipids (Ji et al., 2019). Linoleic acid is beneficial as an essential component of neural membranes of phospholipids, while oleic acid is beneficial as a component of cell membranes (Li et al., 2022).

POTENTIAL HEALTH BENEFITS

Foxtail millet is also known for its potential benefits in that it contains significant levels of fiber, protein, phytochemicals, and minerals. The millet is also proven to contain antioxidants, low glycemic index, and hypolipidemic properties (Sharma & Niranjan, 2018). As mentioned before, foxtail millet contains a lot of essential nutrients and bioactive compounds, which possess numerous health benefits for the human body, such as unsaturated fatty acids. Linoleic acid is beneficial as a substrate for prostaglandin synthesis, which is crucial for maintaining neuronal blood flow, while oleic acid is used to replace saturated fats, lower cholesterol levels, and reduce inflammation to enhance heart conditions. Hence, foxtail millet is considered the easiest to digest and the least likely to cause allergic reactions (Li et al., 2022). Foxtail millet is also considered an excellent source of endogenous antioxidants and since these grains possess a low glycemic index it is appropriate for those with diabetes mellitus (Narayanan et al., 2016).

The foxtail millet can stimulate and improve appetite. This is due to the fact that it contains a significant amount of tannins (Sharma et al., 2015). The foxtail millet is a diuretic because it enhances the function and action of the gallbladder which is one of the finest health advantages of foxtail millet. The foxtail millet also softens the skin and hydrates it (Reaz et al., 2023). It also can regulate cholesterol and blood sugar. The strong antioxidant content and significant resistant starch content in the foxtail millet can lower inflammation, which may support anti-aging, anti-cancer, and other advantages (Singh et al., 2022). Since the foxtail millet is naturally gluten-free, it is able to enhance the general health of the digestive system (Reaz et al., 2023).

The nutritional content of foxtail millet, which has benefits for cholesterol, blood pressure, anthropometry, and antioxidant activity, among other health benefits, gives rise to several advantageous characteristics of foxtail millet. It has been mentioned that fox millet contains antioxidants, metal chelators,

and reductants in the soluble and insoluble phenolic extracts which are beneficial as natural antioxidant sources (Taofiq et al., 2017). Regarding the benefits against hyperglycemia, foxtail millet has non-starchy carbohydrates and fiber that reduce blood sugar. According to Narayanan et al. (2016), fox millet has a low glycemic index, which may also aid in lowering blood sugar. Eating foxtail millets can help reduce hyperlipidemia and raise high-density lipoprotein cholesterol (HDL-C) (Sabuz et al., 2023). Furthermore, the protein content of foxtail millet contributes to lowering cholesterol and triglyceride levels. Due to the inverse relationship between blood pressure and the dietary fiber, protein, and minerals contained in whole grains, foxtail millet also provides advantages in terms of anti-hyperglycemic effects (Ren et al., 2018). According to Hou et al. (2018), foxtail millet consumption has been linked to a significant reduction in body mass index (BMI), body weight, and degree of obesity because of its high protein content. The protein in fox millet also has phenolic compounds, fiber, and antioxidants that help lower body weight (Narayanan et al., 2016).

BIOACTIVITY AND MECHANISM OF ACTIONS

The primary nutritional constituents of foxtail millet include starch, protein, and fat. When undergoing modification processes, such as various cooking or processing methods, these key components experience alterations. Different modification techniques yield different effects on these components. Consequently, the changes in the properties of these constituents during the modification process significantly influence the overall processing quality of foxtail millet (Rao et al., 2017).

In addition to their rich content of starch, protein, and fat, foxtail millets are also recognized for their diverse array of bioactive phytochemicals, which offer various health benefits to humans. Among these phytochemicals, polyphenols stand out as particularly notable. Plant-based polyphenols, known as naturally occurring antioxidants, are essential for reducing the risk of non-communicable illnesses and oxidative stress. They may help lessen illnesses that are associated with oxidative stress, including sickle cell anemia, neurological disorders, cardiovascular disorders, and chronic fatigue syndrome. Polyphenols also possess a range of other bioactive properties including anticarcinogenic, anti-inflammatory, antiviral, and neuroprotective effects. The dietary intake of polyphenols can be significant, potentially reaching up to 1 gram per day, surpassing the levels of any other known dietary antioxidant. Foxtail millets contain various types of polyphenols; as it is rich in ferulic, chlorogenic, caffeic, p-coumaric, and syringic acids (Akanbi et al., 2019). It is known that the phytochemicals in foxtail millet work as metal chelating agents, radical quenchers, reducing agents, and free radical scavengers. Through these methods, they protect against oxidative stress and consequent cellular damage by efficiently inhibiting the generation of hydroperoxides, singlet oxygen molecules, and reactive oxygen species (ROS) (Sharma & Sharma, 2022).

The release and alteration of bioactive compounds within the gastrointestinal (GI) tract are crucial processes that influence their potential health benefits. Thus, it becomes imperative to investigate how digestion impacts the stability of these compounds, subsequently affecting their bioavailability and bioaccessibility. These factors ultimately determine the extent to which the body can absorb and utilize these bioactive compounds, thus impacting their potential health-promoting effects (Hutabarat & Bowie, 2022). The digestion and subsequent absorption of functional components within starch also play a crucial role in unlocking their health-promoting properties in the human body. Although heat processing helps starch be more digestible, a portion of it still resists mammalian enzymes and is hence referred to as resistant starch. This kind of starch affects glucose and lipid metabolism, resulting in the positive effects of the gut for weight control. Furthermore, this starch hydrolysis condition enables the slow release of glucose in the digestion process, which helps in tackling glycemic-dependent disorders (Bojarczuk et al., 2022).

Postprandial glucose levels rise when carbohydrate-hydrolyzing enzymes, such as α-amylase and α-glucosidase, break down polysaccharides into glucose, which is then carried into the circulation. Since

phenolic chemicals disrupt the enzymes' active areas, they effectively prevent postprandial hyperglycemia. It is predicted that dietary fiber made from foxtail millet will reduce glucose absorption via several methods (Nyambe-Silavwe et al., 2015). fiber increases the small intestine's viscosity, which prevents glucose from diffusing. Secondly, the starch-digesting enzymes are delayed in their activity when fiber attaches to glucose molecules, lowering their concentration in the small intestine. The high phenolic content of raw foxtail millet has been shown to inhibit intestinal α-glucosidase and α-amylase activity (Hutabarat & Bowie, 2022).

The high concentration of carotenoids and phenolic acids in foxtail millet is thought to be responsible for its remarkable ability to counteract peroxide radicals and demonstrate antioxidant activity. Furthermore, it has been discovered that foxtail millet extracts inhibit the development of MDA breast cancer cells and HepG2 liver cancer cells. The effects of phenolic compounds isolated from foxtail millet on HT-29 cells, which are mutant epithelial cells derived from colorectal cancer, were evaluated. Significant antiproliferative effects were shown by these substances, especially concerning suppressing DNA stratification, which is essential for controlling the early and late phases of carcinogenesis. A different chemical, called BPIS, was shown to have anti-proliferative qualities in HT-29 cells in a mouse model that was immune-deficient. This effect is attributed to the reversal of glycolysis from aerobic to anaerobic metabolism, achieved through the upregulation of miR149 expression. It is well-recognized that miR149 is essential for several cellular functions, such as apoptosis, proliferation, metastasis, chemoresistance, and carcinogenesis (Zhang et al., 2021). Furthermore, a recently discovered 35 kDa protein from foxtail millet bran (FMBP) demonstrated a notable reduction of colon cancer cell proliferation throughout time and at different doses. Normal colon epithelial cells were unaffected by FMBP's cytostatic and cytotoxic actions on colon cancer cells. It works by causing G1 phase arrest, which results in the loss of the mitochondrial transmembrane potential and caspase-dependent apoptosis (Shan et al., 2014; Shi et al., 2019; Hutabarat & Bowie, 2022).

SAFETY AND EFFICACY IN ANIMAL OR HUMAN TRIALS

In terms of animals, foxtail millet has also been proven to be safe and its benefit has been proven, specifically in terms of its gastroprotective effect. As an example, in an experiment done by Lin et al. (2020), rats' ulcerations caused by water immersion restraint stress (WIRS) were examined to determine if foxtail millet had any gastroprotective effects. According to the findings, diets high in millet may prevent ulcers by lowering thiobarbituric acid reactive substances levels, and ulcer index, and raising the non-protein sulfhydryl (NPSH) concentrations. This statement was also supported by Zhang et al. (2022). The research assessed the antiulcer properties of foxtail millet protein hydrolysate (FPH) utilizing a mouse of ethanol-induced gastric ulcers. It is shown that the oxidative status was enhanced, the expression of inflammatory cytokines in the stomach tissue was decreased, the level of activity of antioxidant enzymes was raised, and the ulcerative lesion index was decreased by pretreatment with FPH. It is shown that foxtail millet not only is safe through animal trials but could also treat gastrointestinal disease. These findings are also supported by Chen et al. (2022), where similar research was conducted and 50 mice were given foxtail millet porridge. Foxtail millet was shown to encourage gastric emptying, accelerate the rate of gastrointestinal propulsion, decrease the duration of the first melena defecation, and increase the water content of feces to avoid constipation.

In terms of digestibility, foxtail millet itself has a lower digestibility in contrast with different grains (Mertz et al., 1984). Certain millet varieties may have less protein digestibility due to processing methods that use hydrothermal treatments. Since millet is typically consumed upon cooking, the protein could develop hydrophobic aggregates or more disulfide bonds, decreasing the protein's digestibility (Gulati et al., 2017). However, in certain cases, its digestibility has been found to increase after cooking. For example, IVPD values for raw finger, proso millet, and foxtail were consecutively found to be 72.3, 71.3, and 77.1%.

After cooking, these values rose to 85.5, 91.6, and 88.6% (Ravindran, 1992). In a different study, after the foxtail millet was dehulled, soaked, and cooked, its IVPD rose from 62.3% in its untreated state to 83% (Pawar & Machewad, 2006).

In hypertensive rats, it has been demonstrated that protein hydrolysates made from foxtail millet inhibit the action of angiotensin-converting enzymes, decreasing angiotensin II levels and directly lowering blood pressure. Foxtail millet protein hydrolysate was shown to be equally effective in preventing hypertension as captopril, a commonly used medicine when compared to its therapy (Chen et al., 2016). Furthermore, it has been demonstrated that protein hydrolysates from foxtail millet may reduce ventricular hypertrophy and ameliorate cardiac damage. Importantly, there have been no changes in the percentage weight of the liver or kidneys, indicating that foxtail millet consumption has not had any negative consequences on these organs' functions. After 12 weeks, a diet including foxtail millet significantly lowered the diastolic blood pressure (DBP) by 3.49 mmHg and the systolic blood pressure by 4.13 mmHg in a trial of healthy men and women with moderate hypertension, ages 40 to 65 (Hou et al., 2018).

Even so, foxtail millet could cause an allergic reaction, for instance, in terms of the sensitivity's natural progression and cross-reactivity among different grains. There was a case where a 59-year-old Japanese woman had an allergic reaction to wheat. Since the subject was 43, she had been feeding a budgerigar in her room birdseed that contained millet. The subject experienced anaphylactic shock 20 minutes after consuming noodles made entirely of millet instead of wheat. After being investigated, the subject was thought to have been primarily sensitive to the millet in birdseed, and the formation of wheat allergy was caused by a portion of the patient's IgE antibodies toward millet proteins that also cross-reacted with wheat antigens (Kotachi et al., 2020). This highlights that while foxtail millet offers significant digestive benefits, it may also trigger allergic reactions in certain individuals, highlighting its complex nutritional and functional properties, making it a valuable yet nuanced dietary component.

POTENTIAL TECHNOLOGY FOR FOXTAIL MILLET DEVELOPMENT

Foxtail millet has been known as a nutrient-rich cereal that has been identified as the potential solution to address malnutrition and type 2 diabetes (Sharma et al., 2023). However, due to taste preferences and dietary restrictions, its production has decreased. Foxtail millet has a bland flavor and difficult preparation procedures which make it undesirable to consumers despite its possible advantages (Sharma & Niranjan, 2018). To overcome these challenges and enhance consumers' acceptability of the grain, a variety of technologies and processing techniques may be used to enhance the nutritional value and sensory qualities of foxtail millet.

Extrusion is a processing method that turns raw materials into desired products by applying high pressure and heat (Offiah et al., 2019). This method has been used to improve the nutritional qualities of the foxtail millet. The starch from foxtail millet can become more soluble by the extrusion process, which is advantageous for enhancing the digestion of carbs (Yang et al., 2022). Furthermore, foxtail millet that has been extruded may have higher levels of polyunsaturated fatty acids, such as linoleic acid (Bilal Sajid Mushtaq et al., 2021). This is essential because, although linoleic acid cannot be produced by the body and must be received from diet, it is an essential fatty acid needed for human health. Additionally, foxtail millet's cell walls may depolymerize as a result of the extrusion process, which might lower the grain's β-glucan concentration (Yi et al., 2022). A dietary fiber called β-glucan has been linked to several health advantages, such as lowered blood cholesterol and better blood sugar regulation. On the other hand, the nutritional benefits obtained via extrusion could equalize or surpass the little decrease in β-glucan concentration. Furthermore, extrusion can increase the minerals in foxtail millet's digestibility, which is advantageous for those who suffer from metabolic syndrome (Sharma et al., 2023). A set of disorders known as metabolic syndrome raises the chance of acquiring long-term illnesses including diabetes and obesity. Enhancing

foxtail millet's nutritional digestibility can help ward against these ailments by facilitating the body's efficient use of the nutrients for energy and other metabolic functions.

In addition to extrusion, other processing techniques such as dehulling and milling can improve the acceptance of foxtail millet quality. Dehulling and milling are also essential steps in manufacturing products from foxtail millet. Grain dehulling is the process of taking off the bran and germ from its outer layer, while milling is the process of turning the grain that has been dehulled into flour (Corke, 2015). The nutritional value of foxtail millet can be significantly impacted by either procedure. Dehulling foxtail millet may enhance the availability of its dietary fiber content (Devisetti et al., 2014). The nutrient-rich components and micronutrients that are mainly present in the bran and germ have considerable nutritional value, which increases mineral bioavailability (Nazni & Devi, 2016). Given its starch properties with polysaccharides that are easily absorbed by milling, it would be advantageous for those suffering from metabolic syndrome, especially in boosting the protein content (Kumar et al., 2016).

Developing formulas for foxtail millet is also needed to improve its nutritional quality. According to Bhatta et al. (2023), using foxtail millet in value-added products instead of commonly used cereals like wheat and rice might highlight the nutritional benefits of the grain and increase its adoption by consumers. This development of value-added products can be achieved by a variety of formulation methods. One strategy is to substitute some or all of the wheat flour in already-made goods, such as cookies and bars, with foxtail millet flour. This might raise the product's dietary fiber level and make it a healthier option for customers. Another tactic is to use foxtail millet flour as the main component to create new goods, like papad. This may aid in increasing consumer acceptability of foxtail millet and encouraging its use. By using additional useful components in the formulation, foxtail millet's nutritional advantages can be increased even further. Antioxidant qualities of the product can be enhanced, for instance, by adding antioxidants such as polyphenols and tocopherols (Chauhan et al., 2018). Since probiotics improve intestinal health, they can also increase the product's nutritional value.

FUTURE OUTLOOKS

Foxtail millet could be incorporated into a variety of aspects of the food industry. According to Kumari et al. (2023), one of its functions is to include flour to enhance the flour's nutritional qualities, such as its mineral and fiber content. Furthermore, foxtail millet flour may be utilized in bread formulation, meaning that adding foxtail millet flour to recipes for wheat-based bread enhances the amount of protein, dietary fiber, vitamins, and minerals. When foxtail millet was added at a 30% level, the proportion of 12.84% protein, 88.73% fiber, 11.42% manganese, 43.38% iron, and 34.51% total antioxidant activity increased. This enhanced the nutritional value of bread ready-mix (Passi et al., 2023). Moreover, bread made with foxtail millet flour has a low glycemic index and a high nutritious content. Due to its lower glycemic index, around 52–68, and gluten content compared to other staple foods, foxtail millet is a useful therapeutic alternative for those with diabetes and gluten sensitivity (Yang et al., 2022). Chhavi and Sarita (2012) discovered that bread prepared with foxtail millet flour had a glycemic index (GI) of 49.53, which is considered low GI. It is generally accepted that a GI of 55 indicates low GI (Ahmed et al., 2021). Since low GI bread improves glycemic control and lowers the risk of problems from blood sugar variations, it is advantageous for those with diabetes or those trying to control their blood sugar levels (Ren et al., 2022).

Foxtail millet can also be applied to the noodles to improve the protein and nutrient content. According to Meherunnahar et al. (2023), foxtail millet noodles were found to have contained significantly more than 14.78% protein when compared to commercial noodles which makes it an excellent source of dietary protein, with the potential to meet the daily protein requirements of humans. Furthermore, foxtail millet noodles also showed an increase in 5.37% fiber and 2.61% ash content. The increase in the ash content and dietary fiber in foxtail millet noodles increases their nutritional value and potential health

benefits, promoting overall well-being and digestive health. As for the carbohydrate, the foxtail millet noodles showed a lower carbohydrate content (57.74%) when compared to the commercial noodles (67.07%) which provide numerous health benefits, including improved colon digestion and reduced constipation associated with refined grain flours (John Calvien Hutabarat & Aditya Bowie, 2022).

Foxtail millet can grow well in dry tropical or wet tropical climates, making it able to withstand drought, and may potentially become increasingly important in future food supplies, especially as temperatures rise and global conditions become drier (Kheya et al., 2023). Moreover, foxtail millet will show a positive impact in the future since there is an increasing demand for healthier and sustainable food options. Foxtail millet is suitable for tackling issues related to food and nutrition security since it may yield food that has substantial health advantages. Particularly in regions impacted by climate change and food poverty, the usage of millet has grown dramatically to support equitable and sustainable agricultural growth. Millets have the potential to be a practical crop solution for several agricultural problems, including poverty, hunger, and climate change, and Bangladesh stands out as one such place (Kheya et al., 2023). Furthermore, the UN Food and Agriculture Organization (FAO) has emphasized the potential of millet to improve food and nutrition security, especially in regions with high rates of poverty and malnutrition.

CONCLUSION

Foxtail millet is a widely cultivated cereal grain in Asia and Africa that is rich in bioactive substances. Its rich mineral and fiber content helps to promote health maintenance, especially for glycemic-dependent disorders. However, compared to other grains, it has a lower digestibility, containing less protein digestibility due to its cooking processing methods with hydrothermal treatments that create hydrophobic aggregates. Nevertheless, its incorporation into the food industry as flour adjustment has shown promise with its abundant crude fiber nutritional value. In order to fulfill the consumers' preferences, its quality control requires further adjustment to their dietary restrictions and taste preferences. In future studies, this can be done by improving the sensory qualities of the foxtail millet through improvement in milling strategy and further validation of its safety and efficacy.

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