

The Nutritional and Health Properties of Millet: Its Bioactive Compounds in the Prevention and Management of Chronic Diseases

Sunil Kumar Prajapati¹, Deepak Kumar Rawat² and Shikhar Verma³

¹Ph.D. Research Scholar, Division of Agronomy, ICAR-Indian Agricultural Research Institute, New Delhi

²Teaching Associate, Department of Crop Physiology, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, (U.P.)

³Ph.D. Research Scholar, Department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, (U.P.)

SUMMARY

Millet, a cereal grain, has been identified as a functional food with various health advantages due to its rich composition of bioactive compounds such as polyphenols, flavonoids, and phytosterols. These bioactive compounds have been linked to the prevention and management of chronic illnesses. Millet's bioactive compounds have been demonstrated to possess multiple health-promoting properties, including anti-inflammatory, antioxidant, and antidiabetic effects. These properties have been associated with the prevention and management of chronic illnesses such as cardiovascular disease, diabetes, and cancer. Polyphenols in millet have been shown to have cardio-protective effects by decreasing cholesterol levels, enhancing blood pressure, and reducing oxidative stress. Moreover, phytosterols in millet have been found to lower cholesterol levels, reducing the risk of heart disease. Millet's bioactive compounds may also have anti-cancer properties, as the flavonoids in millet have been shown to inhibit cancer cell growth and induce programmed cell death in cancer cells. Additionally, millet is an excellent source of dietary fiber, which has a prebiotic effect that supports the growth of beneficial gut bacteria. This can enhance gut health, which is increasingly recognized as a vital factor in overall health.

INTRODUCTION

Millet plays an essential role as crops for farmers who cultivate on dry soil. These crops are highly nutrient-dense and environmentally friendly. Unfortunately, in India, their consumption has been on the decline due to the difficulty of their preparation. To revive the demand for millets in India, it is crucial to connect all stakeholders in the production-to-consumption value chain onto a single platform and link poor dry land farmers with the market and consumers. The importance of nutrition as a foundation for healthy development cannot be overstated. Modern individuals are increasingly conscious of their healthy lifestyle choices to combat metabolic disorders and lifestyle diseases. This publication reviews scientific empirical investigations carried out in India and around the world on the nutritional characteristics, functional aspects, and health benefits of millets, from seed structure through to processed products. Furthermore, this publication delves into the nutritional evaluation of value-added sorghum product technologies developed and standardized under the IIMR-led consortium of NAIP's sub-project on the millets value chain, undertaken by NIN. Micronutrient studies have shown that these products have reasonably low glycemic index and glycemic load and are highly nutritious. Recipes and preparation methods for sorghum/millet processed products are also provided to benefit various stakeholders, including researchers, the academic fraternity, customers, and entrepreneurs. This timely content is expected to aid researchers and raise awareness globally about the tremendous nutritional benefits of millets. In conclusion, millets are an essential crop for dry land farmers, and their nutritional benefits are undeniable. Revitalizing the demand for millets in India requires a collaborative effort to connect all stakeholders in the value chain and promote the consumption of these nutrient-dense and environmentally friendly crops.

Millet is a nutritious cereal grain that is packed with a range of health-promoting properties. It is a rich source of essential vitamins and minerals such as B vitamins, iron, magnesium, and zinc, which are important for maintaining good health. Millet also contains bioactive compounds such as polyphenols, flavonoids, and phytosterols, which have been shown to possess various health benefits (Samtiya *et al.*, 2021). These compounds have been linked to the prevention and management of chronic diseases such as cardiovascular disease, diabetes,

and cancer. The polyphenols in millet have been found to have cardio-protective effects by reducing cholesterol levels, improving blood pressure, and reducing oxidative stress. Additionally, the phytosterols in millet have been found to reduce cholesterol levels, which can lower the risk of heart disease. Millet is also a good source of dietary fiber, which can improve gut health by promoting the growth of beneficial gut bacteria. This can have a positive impact on overall health, as gut health is increasingly recognized as an important factor in overall well-being. Furthermore, millet is gluten-free and can be a good alternative for people with celiac disease or gluten sensitivity. It is also a low glycemic index food, which means that it can help regulate blood sugar levels and may be beneficial for people with diabetes. Millet is a highly nutritious and versatile grain that is rich in essential vitamins and minerals, as well as bioactive compounds with health-promoting properties. Its consumption has been linked to the prevention and management of chronic diseases, making it a valuable addition to a healthy and balanced diet.

Health Benefits of Millets

Millets are a type of cereal crop that not only serve as a staple food but also offer numerous potential health benefits. Epidemiological studies have shown that consuming millets can reduce the risk of various diseases, including heart disease, diabetes, and cancer. Millets also have the potential to improve the digestive system, detoxify the body, boost respiratory health and immunity, increase energy levels, and enhance muscular and neural systems. In addition, they have been found to be protective against degenerative diseases such as metabolic syndrome and Parkinson's disease. Millets are rich in a variety of nutrients, including resistant starch, oligosaccharides, lipids, and antioxidants. These nutrients are believed to be responsible for the numerous health benefits of millets. Resistant starch, for example, is beneficial for gut health, while oligosaccharides can help boost immunity. Lipids provide energy, and antioxidants combat free radicals, reduce inflammation, and prevent oxidative stress in the body.

1. Cardiovascular Diseases

Millets are known to be rich sources of magnesium which helps in reducing blood pressure and the risk of heart strokes, especially in atherosclerosis (Ambati & Sucharitha, 2019). The presence of potassium in millets also helps in keeping blood pressure low by acting as a vasodilator and reducing cardiovascular risk. The plant lignans present in millets have been found to protect against certain cancers and heart diseases by converting into animal lignans in the presence of microflora in the digestive system. The high fiber content in millets plays a major role in lowering cholesterol levels by eliminating LDL from the system and increasing the effects of HDL. Studies have shown that consumption of millets can lower blood glucose, serum cholesterol, and triglycerides compared to rice and other minor millets. Additionally, finger millet, proso millet, and pearl millet have been found to lower serum triglycerides in hyperlipidemic rats, thus reducing the risk of cardiovascular disease. The presence of antioxidants in pearl millet further makes it beneficial for heart health. Regular consumption of whole grains, including millets, has been found to reduce the risk of cardiovascular disease and total mortality. The components present in grain sorghum can also be used as food ingredients or dietary supplements to manage cholesterol levels in humans. Overall, the consumption of millets can have significant health benefits, especially for those at risk of cardiovascular diseases.

2. Diabetes Mellitus

Diabetes mellitus is a chronic metabolic disorder characterized by high blood sugar levels and changes in carbohydrate, protein, and lipid metabolism. It is the most common endocrine disorder and can result from either deficient insulin production (type 1) or combined resistance to insulin action and insulin secretion (type 2). Consuming millets, which are rich in magnesium, can increase the efficiency of insulin and glucose receptors in the body and help prevent diabetes. Finger millet and sorghum-based diets have been shown to have lower glycemic responses due to their high fiber content and alpha-amylase inhibition properties (Dayakar Rao *et al.*, 2017). Sorghum is also rich in slow-digestible starch, making it favorable for dietary management and metabolic disorders such as diabetes and hyperlipidemia. Pearl millets are known to increase insulin sensitivity and lower triglyceride levels. They are effective in controlling diabetes because of their high fiber content, which slows

down digestion and glucose release into the bloodstream, keeping blood sugar levels stable for extended periods. Polyphenols found in finger millets and other millet varieties have shown significant antidiabetic and antioxidant properties, as well as inhibitory effects on cataractogenesis. The consumption of millet grains has the potential to prevent and treat diabetes by reducing glycemic responses and improving insulin sensitivity.

3. Gastrointestinal Disorders

The regulation of the digestive process can result in increased nutrient retention and a reduced likelihood of developing more severe gastrointestinal conditions such as gastric ulcers or colon cancer, while the fiber content present in millets aids in eliminating disorders like constipation, excess gas, bloating, and cramping. Furthermore, the ingestion of gluten in susceptible individuals can trigger an immune-mediated enteropathic disease known as celiac disease, and adhering to a gluten-free diet can significantly impact food consumption within the grain food group, with the replacement of cereals like wheat, barley, and rye-based foods made from gluten-free grains like rice, corn, sorghum, millet, amaranth, buckwheat, quinoa, and wild rice potentially aiding those following a gluten-free diet, and since millets are gluten-free, they have considerable potential in foods and beverages and can fulfill the growing demand for gluten-free foods, and they are also suitable for individuals who suffer from celiac disease.

4. Cancer

According to literature values, millet grains are rich in phenolic acids, tannins, and phytate, which have been shown to reduce the risk of colon and breast cancer in animals. The fiber and phenolic compounds in sorghum and millet have been attributed to a lower incidence of esophageal cancer compared to those who consume wheat or maize. Recent research has demonstrated that consuming more than 30 grams of fiber per day is one of the best and easiest ways for women to reduce their chances of developing breast cancer by over 50%. Sorghum has well-documented anti-carcinogenic properties, and studies have shown that consumption of sorghum can have positive health impacts on cancer through its polyphenols and tannins, which possess anti-mutagenic and anti-carcinogenic properties and can act against human melanoma cells while also exhibiting positive melanogenic activity. In rat liver, procyanidin extracts from sorghum may induce cytochrome P-450, a protein capable of converting certain promutagens to mutagenic derivatives. Epidemiological data from various regions of the world, including Sachxi Province in China and studies by Van Rensburg in 1981, demonstrate that the incidence of esophageal cancer is lower with sorghum consumption than with wheat or corn consumption, as evidenced by lower mortality rates observed in communities consuming sorghum.

5. Detoxification (Anti-oxidant Properties)

Millet, a type of cereal grain, is known for its high antioxidant content, which has been found to neutralize free radicals that can lead to cancer and eliminate harmful toxins from the body, such as those found in the kidneys and liver. Polyphenols, including quercetin, curcumin, ellagic acid, and other beneficial catechins found in millet, play a crucial role in promoting proper excretion and neutralizing enzymatic activity in these organs. As such, researchers have given significant attention to the potential health benefits of polyphenols in human health. Studies have shown that both soluble and insoluble bound phenolic extracts of various types of millet, including kodo, finger, foxtail, proso, pearl, and little millets, exhibit antioxidant, metal chelating, and reducing powers. Foxtail millet, for example, contains 47mg polyphenolics/100 g and 3.34 mg tocopherol/100 g (wet basis), while proso millet contains 29 mg polyphenolics/100 g and 2.22 mg tocopherol/100 g (wet basis). A positive and significant correlation has been observed between polyphenolic content and radical cation scavenging activity. In addition, over 50 phenolic compounds have been identified in several classes, including phenolic acids and their derivatives, dehydrodiferulates and dehydrotriferulates, flavan-3-ol monomers and dimers, flavonols, flavones, and flavanonols in various types of whole millet grains. Millet grains, therefore, can be utilized as functional food ingredients and natural sources of antioxidants. Several types of millet, including kodo, finger, little, foxtail, barnyard, and sorghum, have been screened for free radical quenching activity using electron spin resonance (Dey *et al.*, 2022). Finger millet, in particular, has been found to have potent radical-scavenging activity that is higher than those of wheat, rice, and other species of millet. Furthermore, defatted foxtail millet

protein hydrolysates exhibit antioxidant potency, indicating that millets may serve as natural sources of antioxidants in food applications and as nutraceuticals and functional food ingredients for health promotion and disease risk reduction.

CONCLUSION

In conclusion, millet is a highly nutritious cereal grain with a range of health benefits. Its bioactive compounds, such as polyphenols, flavonoids, and phytosterols, have been linked to the prevention and management of chronic diseases, including cardiovascular disease, diabetes, obesity, and certain types of cancer. These compounds possess a range of health-promoting properties, including antioxidant, anti-inflammatory, and antidiabetic effects. Moreover, millet is a good source of dietary fiber, which has a prebiotic effect that promotes the growth of beneficial gut bacteria. As such, millet is a valuable addition to a healthy and balanced diet, and its consumption may help reduce the burden of chronic diseases worldwide. Nonetheless, further research is needed to understand the mechanisms by which millet and its bioactive compounds exert their health benefits and to identify optimal doses and modes of consumption. With ongoing research, millet could serve as an important functional food in health promotion and disease risk reduction.

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