Millets for Food and Nutrition Security: A Review

Abstract

Millets are a species of grass plants with small grains that have a remarkable ability to endure severe drought and play an important role in many regions of the country's dietary patterns. Milletspossess an abundance amount of minerals, dietary fibre and phytochemicals which makes them nutritionally superior to conventional food grains. Millet also has a high antioxidant capacity and nutraceutical content, which can help prevent oxidative stress-related disorders like diabetes, cancer, and heart disease. Millets have been shown to provide a variety of physiological benefits such as free radical scavenging activity, anti-inflammatory, antitumor, and anti-diabetic properties. Soaking, germination, malting, decortication, and boiling of millets serve to reduce anti-nutritional elements while improving digestibility and nutritional content. Millet is a potentially tremendous crop but under-explored as compared to cereals. Enhancing the consumption of millets would help in addressing the problem of nutritional security, hidden hunger and combating oxidative stress-induced disorders in developing countries.

Keywords:*Phytochemicals, antioxidant, decortications degenerative diseases.*

1. Introduction

Millets have long been known as poor man's crops, and they have great potential in the food mercenary system as well as in research and development. Millets are commonly planted, small-seeded, highly nutritious crops that can resist drought and require very little irrigation to produce. Its various variants are consumed in many parts of India and play an important role in several states' traditional diets. In the contemporary context, India is dealing with both the pre- and post-progress stages, working in a progressive manner, and making every attempt to achieve the label of developed country. Pre-progress concerns include common fundamental issues such as a lack of healthy nourishment and particular deficiencies such as Fe, Ca, and other nutrients, whereas post-progress issues include obesity, diabetes, cardiovascular disease, and so on. India has designated 2023 as Millet Year in order to promote its valuable nutritional qualities among people and alleviate re-production in all regions.

Coarse Millets consist Finger Millet (Ragi; *Eleusinecoracana*), Barnyard Millet (Sanwa; *Echinochloautilis*), Pearl Millet (Bajra; *Pennisetumglaucum*), Foxtail Millet (Kauni; *Setariaitalica*), Kodo Millet (Arikalu; *Paspalumsetaceum*), Proso Millet (Cheena; *Panicummiliaceum*) and Little Millet (Kutki; *Panicumsumatrense*). All of these millets are high in phytochemicals and insoluble dietary fibre with antioxidant characteristics, as well as a variety of minerals (mostly micronutrients like zinc, magnesium, and iron), dietary energy, and vitamins.

- **Finger millet,** also known as Ragi, is a well-known millet that is commonly consumed by people all over the world. When compared to all whole grains and minerals, ragi has the highest mineral and calcium concentration. It is known as the "wonder grain." It is a protein and amino acid powerhouse. It aids in the reduction of body heat. It also aids in

the healing of ulcers and anaemia. It's an excellent substitute for rice and wheat, especially for diabetics.**(Gull *et al.*, 2014).**

- **Foxtail Millet,** also known as Kangni, was used in ancient times. They have a brief lifespan and are resistant to low soil fertility and drought. These are high in carbs, fibre, and minerals like copper and iron. It helps to keep our bodies healthy and immune. It also aids in the regulation of blood sugar and cholesterol levels.
- **Kodo Millet** is the coarsest millet among the minor millets and is primarily a digestible millet. It is high in phytochemicals and phytate, which aid to lower cancer risks. It aids in the reduction of body weight, which is very important for obese persons. It aids in the treatment of irregular menstrual periods in women. It alleviates knee and joint discomfort. It is also beneficial to diabetics. It alleviates neurological diseases, particularly those affecting the eyes. **(Deshpande *et al.*, 2015).**
- **Little Millet,** also known as saamai or kutki. It helps to prevent constipation and treats any gastrointestinal disorders. It increases men's sperm counts. It is also beneficial for ladies who have irregular periods. Its high fibre content aids in the reduction of fat deposits in the body.
- **Proso Millet,** also known as cheena, is a short-lived plant that is resistant to heat and drought in western India.
- **Barnyard Millet** is another name for Sawan. It's a gluten-free millet with a high calcium, phosphorus, and fibre content. It is also heavy in carbohydrates and fat. It aids in the regulation of body temperature. It is also an excellent anti-oxidant.

2. Nutritional Composition of Millet

"Millets are a staple diet in many African countries; however, they are low in macronutrients like protein and fat while being high in vitamins and minerals. Millets are strong in magnesium, which lessens the severity of asthma, the frequency of migraines, high blood pressure, and the risk of heart attack. These minerals are essential in human nutrition. Millet is also classified as an alkaline-forming food. An alkaline diet is frequently recommended to achieve optimal health and prevent illness/disease". **(Chauhan *et al.*, 2018).**

"Millets have a protein content of 7-12%, a lipid content of 2-5%, a carbohydrate content of 65-75%, and a dietary fibre content of 15-20%. Pearl millet has a higher proportion of proteins (12-16%) and lipids (4-6%) than finger millet, which has a lower proportion of protein (6-8%) and fat (1.5-2%). Millet protein has superior essential amino acid profiles over maize protein. Pearl millet has more niacin than any other cereal, whereas finger millet proteins are distinct due to their high sulphur content. Millet proteins, like cereal proteins, are low in lysine, but they combine well with lysine-rich vegetable (leguminous) and animal proteins to generate nutritionally balanced composites with high biological value. Small millets contain more nutrients than fine cereals. Finger millet has the highest calcium content (300-350 mg/100 g), while other tiny millets are high in phosphorus and iron". **(Saini *et al.*, 2021).**

When compared to other grains, millet provides 75% more carbs and less fat (2-5%) than maize, rice, and sorghum. Millets have a complex carbohydrate content of 65-75%, a protein content of 5.6-12%, a fat content of 2-5%, a crude fibre content of 15-20%, and a mineral content of 2.5-3.5%.

Table:1Main millets nutritional composition in contrast to major cereals (at 12% moisture; per 100 g edible portion)

Nutrients	Finger Millet	Pearl Millet	Foxtail Millet	Proso Millet	Rice (Brown Medium Grain Raw)	Corn Grain (white)	Sorghum	Oats	Barley (Pearled Raw)
Proximate Composition									
• *Moisture(g)*	***13.1***	*12.4*	*11.2*	*11.9*	*12.4*	*10.4*	*12.4*	*8.2*	*10.1*
• *Energy (kcal)*	*336*	*361*	*331*	*341*	*362*	*365*	*329*	***389***	*352*
• *Protein(g)*	*7.7*	*11.6*	*12.3*	*12.5*	*7.5*	*9.4*	*10.6*	***16.9***	*9.9*
• *Fat(g)*	*1.5*	*5*	*4.3*	*1.1*	*2.7*	*4.7*	*3.5*	***6.9***	*1.2*
• *Dietary fibre (g)*	*11.5*	*11.3*	*2.4*	-	*3.4*	*7.3*	*6.7*	*10.6*	***15.6***
• *Carbohydrates (g)*	*72.6*	*67.5*	*60.9*	*70.4*	*76.2*	*74.3*	*72.1*	*66.3*	***77.7***
• *Minerals(g)*	*2.7*	*2.3*	***3.3***	*1.9*	-	-	*1.6*	-	-
Minerals and Trace Elements									
• *Calcium(mg)*	***350***	*42*	*31*	*14*	*33*	*7*	*13*	*54*	*29*
• *Iron(mg)*	*3.9*	***8***	*2.8*	*0.8*	*1.8*	*2.7*	*3.36*	*4.7*	*2.5*
• *Magnesium*	*137*	*137*	*81*	*153*	*143*	*127*	*165*	***177***	*79*
• *Phosphorus*	*283*	***296***	*290*	*206*	*264*	*210*	*222*	*523*	*221*
• *Manganese (mg)*	***5.94***	*1.15*	*0.6*	*0.6*	-	-	*0.78*	-	-
• *Molybdenum(mg)*	*0.102*	*0.069*	***0.7***	-	-	-	*0.039*	-	-
• *Zinc (mg)*	*2.3*	*3.1*	*2.4*	*1.4*	*2.02*	*2.21*	*1.7*	***3.97***	*2.1*
• *Sodium (Mg)*	*11*	*10.9*	*4.6*	*8.2*	*4*	***35***	*2*	*2*	*9*
• *Potassium(mg)*	***408***	*307*	*250*	*113*	*268*	*287*	*363*	*429*	*280*
Vitamins									
• *Thiamine (mg)*	*0.42*	*0.33*	*0.59*	*0.2*	*0.41*	*0.39*	*0.33*	***0.76***	*0.19*
• *Riboflavin (mg)*	*0.19*	***0.25***	*0.11*	*0.18*	*0.04*	*0.2*	*0.096*	*0.14*	*0.11*
• *Niacin (mg)*	*1.1*	*2.3*	*3.2*	*2.3*	*4.3*	*3.6*	*3.7*	*0.96*	***4.6***
• *Total folic acid(µg)*	*18.3*	*45.5*	*15*	-	*20*	-	*20*	***56***	*23*
• *Vitamin E(mg)*	***22***	-	-	-	-	-	*0.5*	-	*0.02*

(1) Gopalan et al. (1999).

(2) Gopalan et al. (2004).

(3) USDA National Nutrient Database for Standard Reference, Release 28 (2016).

3. Millets and their Health Benefits

The world is dealing with a number of health challenges including chronic diseases. According to the ***Global Nutritional Report 2021,*** there are 149.2 million stunted children under the age of five, 45.4 million wasting children, and 38.9 million overweight children. Over 40% of the population suffers from severe obesity, overweight, and malnutrition. A nutrient-imbalanced diet is the root cause of all of these disorders. The United Nations Food and Agriculture Organization estimates that 795 million people, or about 10% of the world's population, are malnourished. India has the world's highest population of undernourished people. Around 194.6 million individuals, or 15.2% of India's total population, are malnourished. According to the data from the 2022 Global Hunger Index study, India ranks 107th out of 119 countries. Millets are ranked sixth in terms of total cereal grain production in the globe. These are still used as staple foods in many parts of the world. **(FAO *et al.*, 2022).**

Regulate Blood Glucose Levels

When compared to wheat and maize, millets are higher in nutrients, gluten-free, and have a low glycaemic index (54-68). The presence of a high amount of dietary fibre, proteins with all essential amino acids, vitamins, and minerals aids in blood sugar stabilization. Millets can be included in a diabetic's balanced diet to help minimize blood sugar increases and promote insulin sensitivity.

Millets in Cardiovascular Disease

The leading cause of heart attacks and strokes is a poor diet. Millets can help reduce the prevalence of cardiovascular disease. In hyperlipidaemic rats, finger and proso millet reduced plasma triglycerides. Furthermore, the inhibitory effects of phenolic extracts from millets such as kodo, finger, proso, foxtail, tiny, and pearl millets on lipid peroxidation were investigated. In the food systems employed in this investigation, all kinds inhibited lipid oxidation effectively, however kodo millet inhibited lipid peroxidation better than butylated hydroxy anisole at 200 ppm.

Battle Cancer Cells

Millet grains contain antinutrients such as tannins, phytates, and phenolic acids. It has been demonstrated that the antinutrients found in millets help reduce the risk of colon and breast cancer in mice. In vitro, millet phenolics may be useful in preventing cancer development and progression. A fibre-rich diet of whole grains like millet and fruits protects menopausal women from breast cancer. Whole grains are high in fibre, which provides the most protection. Resistant starch also aids in the release of necessary metabolites such as short chain fatty acids in the colon, particularly butyrate, which aids in colonic cell proliferation stabilization as a preventive strategy for colon cancer.

Promotes Digestion

Millets include a high level of dietary fibre, which helps to improve digestive system function. It treats constipation, flatulence, bloating, and cramping, as well as improving the overall health of other key organs such as the liver and kidneys and boosting the immune system.

Millets in Aging

Millets have the ability to defend against aging. A key factor contributes to issues such as diabetes and aging. Non-enzymatic glycosylation is a chemical process. Millet grains have antioxidant properties due to their high antioxidant and phenolic content. These antioxidant activities contribute to the prevention of aging and metabolic syndrome. Methanolic extracts of finger millet and kodo millet have been shown to prevent collagen glycation and crosslinking.**(Singh and Chauhan, 2019).**

Millets in Gallstones

Some researchers conducted a study that found that eating meals high in fibre (both soluble and non-soluble) helped women avoid gallstones. According to one study, women who ate

high-fibre foods had a 13% lower risk of getting gallstones than women who ate the least number of fibre-rich foods.

4. Anti-Nutrient Factors in Millets

"Millet contains anti-nutrients such as phytates, polyphenols, tannins, and trypsin inhibitors in addition to nutritive characteristics. Anti-nutrients are naturally occurring chemicals that impair nutrient digestion, absorption, and utilization and may have additional negative effects in humans and animals. Traditional processing processes including as decortication, soaking, roasting, germination, malting, and fermentation can assist to minimize these anti-nutrients. Anti-nutritional factors like as fibre, phytate, and enzyme inhibitors are affected by processing, which can increase or decrease the bioavailability of micro and macronutrients". **(Bora, 2014).**

Phytates

"Phytates and phytic acids are naturally occurring compounds in the plant kingdom. Phytate is also known as myo-inositol-1, 2, 3, 4, 5, 6-hexakis dihydrogen phosphate, and it can be found in foods at concentrations ranging from 0.1 to 6.0%. Phytates account for 50 to 80% of total phosphorus in seeds. Because plant-based foods contain more phytic acids than animal-based foods, developing-country vegetarian diets lead to high intake levels. In general, phytic acids reduce mineral bioavailability and have a significant impact on newborns, pregnant and nursing women when substantial amounts of cereal-based diets are consumed".**(Grases*et al.*, 2017).**

Tannins

Tannins are a type of anti-oxidant polyphenol that is commonly found in food and beverages. After cellulose, hemicellulose, and lignin, tannins are the plant's fourth most prevalent component. In India, the daily consumption of tannin is 1500-2500 mg, according to dietary studies. A daily intake of less than 1.5 to 2.5g tannin has no negative consequences. However, over this limit causes disorders such as anemia and osteoporosis, as well as worsening cancer. However, some carcinogenic chemicals can cause cancer and necrosis of liver cells.

Polyphenols

Polyphenols are regarded essential for life because they help to maintain one's physique and health throughout one's life. They are antimutagenic, anticarcinogenic, antiestrogenic, anti-inflammatory, antiviral, and platelet aggregation inhibitors that can be used to treat and prevent disorders.

Millet has a strong antioxidant potential and contains about 50 phenolic components such as phenolic acids and their derivatives, flavanols, flavones, and flavanonols. Soluble phenolic chemicals are commonly found in the pericarp of the kernel and the bound form of the cell wall.Polyphenols are classified into simple phenols, phenolic acids, tannins, flavonoids, lignans, lignins, curcuminoids, coumarins, and stilbenes based on their carbon skeleton. Pearl millet has a polyphenolic concentration ranging from 502.78 to 767.54 mg/100g. **(Shahidi and Chandrasekara, 2013).**

Table:2Anti-nutritional factors

Millets	Anti-nutrients
Barnyard Millets [Sanwa]	Phytic and Tannin Acid
Finger Millets [Ragi]	Tannins, Non-Starch Polysaccharides-Glucans, Oxlates, Phytates and Protease Inhibitors,
Foxtail Millets [Kakum]	Phytic Acid and Phenolic Compound
Pearl Millets [Bajra]	Phytic Acid, Polyphenols, Alpha Amylase Inhibitors
Porso Millets [Chena]	Phytic Acid, Polyphenols, Alpha Amylase Inhibitors
Sorghum [Jawar]	Cyanogenic Glucoside and Tannins

(Bora, 2014)

5. Conclusion

Millet is an important food source for animals and birds. However, millet has enormous promise for population nutrition due to its low cost and ease of growing. Millet has a variety of nutrients, antinutrients, and antioxidants, making it an important component of dietary and nutritional balance in foods. Millet anti-nutrients (such as polyphenols, phenolic compounds, tannins, and flavonoids) are not directly related to nourishing the body but play a major role in the prevention and treatment of diseases such as diabetes, cardiovascular disease, cataract, cancer, inflammation, gastrointestinal issues, and so on. Millet is unique among cereals in that it is alkaline-forming and gluten-free. Millet is the finest gluten-free alternative for celiac patients.

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