Millets for Food and Nutrition Security: A Review

Abstract

Millets are group of grass~~y~~ plants with small grains possessing a remarkable ability to survive under severe drought and play a big part in dietary patterns of many parts of the nation. Millets possess an abundance amount of minerals, dietary fibre and phytochemicals which makes them nutritionally superior to conventional food grains. –Millet also exhibits high antioxidant capacity and nutraceutical which have a significant role in the prevention of oxidative stress-induced diseases such as diabetes, cancer and heart diseases Millets have been exhibited to show a wide range of physiological benefits as free radical scavenging activity, anti-inflammatory, antitumour and anti-diabetic characteristics. Processing methods such as soaking, germination, malting, decortications and cooking of millets helps in reducing the anti-nutritional factors and it enhances the digestibility and nutritional quality. 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.

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1. Introduction

Millets have been known as poor man's crops for a long time, and have good potential in the mercenary system of food and in research and development. Millets are small-seeded widely grown, highly nutritive crops that can withstand in drought situations and require very little irrigation for production. Its play a significant role in the traditional diet of many states of India and its different varieties are consumed in many regions of India. In the current milieu, India is confronting both the pre and post progress stages and working in progressive manner and making every possible effort to get a developed country tag. Pre-progress issues are the common fundamental issues as lack of healthy sustenance and distinctive insufficiencies like Fe, Ca, and other nutrients while post progress issues are for example obesity, diabetes, cardiovascular disease etc. India has celebrating 2023 as Millet's year to introduce its valuable nutritional quality among people and alleviate re-production in every region.

Coarse Millets consist Finger millet (Ragi; *Eleusine coracana*), Barnyard millet (Sanwa; *Echinochloa utilis*), Pearl millet (Bajra; *Pennisetum glaucum*), Foxtail millet (Kauni; *Setaria*), Kodo millet (Arikalu; *Paspalum setaceum*), Proso millet (Cheena; *Panicum miliaceum*) and little millet (Kutki; *Panicum sumatrense*). All of these millets are abundant in various phytochemicals and insoluble dietary fibre with antioxidant properties, a variety of minerals (mainly micronutrients such as zinc, magnesium and iron), dietary energy and several vitamins.

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- **Finger Millet** popularly known as Ragi is a well-known millet & consumed widely by the people all over the world. Ragi has the highest mineral & calcium content when compared to all whole grains & minerals. It is called as wonder grain. It is a powerhouse of protein & amino acids. It helps to reduce the heat of the body. It also helps to heal ulcers & anaemia. It's a great replacement for rice & wheat especially diabetic patients **(Gull *et al.*, 2014).**
- **Foxtail Millet** popularly known as Kangni which was used in ancient days. They are short duration, tolerant to low soil fertility and drought. These are rich in carbohydrates, dietary fibre and minerals such as copper and iron. It helps to keep our body strong and immune. It also helps to control blood sugar and cholesterol levels.
- **Kodo Millet** is a coarsest millet among the minor millets, is basically a digestion friendly millet. It is rich in phytochemicals, phytate that helps in reduction of cancer risks. It helps to reduce the body weight which is most needed for obese people. It helps to overcome irregular period problems in women. It helps to reduce knee & joint pains. Also, it is good for diabetic people. It reduces nervous disorders especially in eyes **(Deshpande *et al.*, 2015).**
- **Little Millet** known as saamai or kutki. It helps to prevent constipation & heals all the problems related to stomach. It improves the semen counts of men. It also helps for women with irregular periods problems. Its high fiber helps to reduce the fat depositions in the body.
- **Proso Millet** commonly known as cheena which is short duration tolerant to heat and drought conditions of western India.
- **Barnyard Millet** known as sawan. It's a gluten free millet with high calcium, phosphorous & fiber. It is high in carbohydrates & fat too. It helps to maintain the body temperature. It acts as a good anti-oxidant too.

2. Nutritional composition of Millet

Millets are staple food for many African countries; however, they are low in macro nutrients such as protein and fat but rich in vitamins and minerals. Millets are a good source of magnesium which reduces the severity of asthma, frequency of migraines, lowers high blood pressure and reduces the risk of heart attacks. These nutrients play important roles in human nutrition. Millet is also known as an alkaline forming food. Alkaline based diet is often recommended to get better optimal health and prevent illness/ diseases **(Chauhan *et al.*, 2018).**

The millets contain 7-12% protein, 2-5% fat, 65-75% carbohydrates and 15-20% dietary fibre. Among them, pearl millet contains considerably high proportion of proteins (12-16%) as well as lipids (4-6%) whereas; finger millet contains lower levels of protein (6-8%) and fat (1.5-2%). The essential amino acid profiles of the millet protein are better than maize. The niacin content in pearl millet is higher than all other cereals whereas, finger millet proteins are unique because of the sulphur rich amino acid contents. Similar to cereal proteins, the millet proteins are poor sources of lysine, but they complement well with lysine-rich vegetable (leguminous) and animal proteins form nutritionally balanced composites of high biological value. Small millets are more nutritious compared to fine cereals. Finger millet is the richest source of calcium (300-350 mg/100 g) and other small millets are good source of phosphorous and iron **(Saini *et al.*, 2021).**

When comparing millet with other cereals, millet contains 75% of carbohydrates and is low in fat (2–5%) content than maize, rice, and sorghum. Millets contain 65–75% of complex carbohydrates, 5.6–12% protein, fat, 2–5%, 15–20% crude fiber and 2.5–3.5% minerals.

Table:1 Nutritional composition of main millets in comparison to major cereals (@ 12% moisture; per 100 g edible portion)

Nutrients	Finger millet	Pearl millet	Foxtail millet1	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

World is facing several health issues and chronic diseases. According to **Global Nutritional Report, 2021** There are 149.2 million children under 5 years of age are stunted 45.4 million are wasted and 38.9 million are overweight. Over 40% population are suffering from serious levels of obesity, overweight and under nutrition. The common cause behind all these diseases is nutrient imbalanced diet. United Nation Food and Agriculture Organization provided data in which they reported 795 million people that are around 10% of world population are undernourished. India covers world's largest undernourished population. About 194.6 million people, i.e., 15.2% of total population of India, are undernourished. As per the data from 2022 Global Hunger Index report, India is on 107th position among 119

countries. According to the total world agriculture production of cereal grains, millets hold 6th position. These are still using as staple food in several regions of world **(FAO et al., 2022).**

Regulate Blood Glucose Levels

Millets, when compared to wheat and maize, are high on nutrients, gluten-free and have a low glycaemic index i.e., 54-68. The presence of a high amount of dietary fibre, proteins with all essential amino acids, vitamins, and minerals helps in stabilizing the blood sugar levels. Millets can be a part of a healthy diet for diabetic patient that prevent blood sugar spikes and promote insulin sensitivity.

Millets in cardiovascular disease

The main reason behind of heart attacks and strokes is unhealthy diet. Millets can be helpful in decreasing the rates of cardiovascular disease. Finger and proso millet have shown reduction in plasma triglycerides in hyper lipidemic rats. Additionally, phenolic extracts from millets such as kodo, finger, proso, foxtail, little, and pearl millets were evaluated to find their inhibitory effects on peroxidation of lipids. All varieties exhibited effective inhibition of lipid oxidation in food systems used in this study and kodo millet exhibited superior inhibition of lipid peroxidation, similar to butylated hydroxy anisole at 200 ppm.

Comment [Ma1]: Any comparative data available on how many people using millets and no heart disease and people use rice or wheat and having high risk of heart disease. When authors are talking about nations food security, it is advised to give some related data as evidence.

Battle Cancer Cells

Antinutrients such as tannins, phytates and phenolic acids are present in millet grains. It has been proved that these available antinutrients in millets help in reducing the risk for colon and breast cancer in animals. Millet phenolics may be effective in the prevention of cancer initiation and progression *in vitro*. A fibre rich diet of whole grains like millet, fruits provide protection against breast cancer in meno-pausal women. Whole grains are rich in fibre that offered the most protection. Resistant starch also helps in the release of required metabolites such as short chain fatty acids in the colon, especially butyrate, which helps in stabilizing colonic cell proliferation as a preventive mechanism for colon cancer.

Promotes Digestion

The presence of a good amount of dietary fibre in millets works well to improve the digestive system function. It combats constipation, flatulence, bloating, cramping, regularizes the bowel function and improves the overall health of other vital organs like liver, kidney and boosts the immune system.

Millets in aging

Millets are potentially useful in protecting against ageing. There is a major factor that causes complications such as diabetes and ageing. The chemical reaction named non-enzymatic glycosylation. Millet grains show antioxidant activities due to richness in antioxidants and phenolic compounds. These antioxidant properties help in preventing ageing and metabolic syndrome. The methanolic extract from finger millet and kodo millet has been found to inhibit glycation and crosslinking of collagen **(Singh and Chauhan, 2019).**

Millets in gallstones

A study has been carried out by some researchers that eating foods that are high in fibre (both soluble and non-soluble) helped women to prevent gallstones. A study reported that the women eating high fibre foods lowered the 13% risk of developing gallstones compared to women consuming the fewest fibre-rich foods.

4. Anti-Nutrient factors in Millets

Beside nutritional properties, millet also contains some anti-nutrients such as phytates, polyphenols, tannins, trypsin inhibitors. These naturally-occurring compounds, anti-nutrients are the substances that reduce nutrient digestion, absorption and utilization and may produce other adverse effects in humans and animals. These anti-nutrients can be reduced with the help of traditional processing methods like decortication, soaking, roasting, germination, malting and fermentation. Processing affects anti-nutritional factors such as fibre, Phytate and enzyme inhibitors, which in turn can enhance or reduce the bioavailability of micro and macro-nutrients **(Bora, 2014).**

Phytates

Phytates or phytic acids occur naturally in the plant kingdom. Phytate is generally known as myo-inositol-1, 2, 3, 4, 5, 6-hexakis dihydrogen phosphate, which is present in foods at various levels ranging from 0.1 to 6.0%. phytates contain about 50 to 80% of the total phosphorous in seeds. Because plant-based foods contain more amount of phytic acids than animal-based foods, the vegetarian diets culture in developing countries contribute to high ingestion levels. Generally, phytic acids affect the bioavailability of minerals and have a strong effect on infants, pregnant and lactating women when large portions of cereal-based foods are consumed **(Grases *et al.*, 2017).**

Tannins

Tannins are considered an important group of anti-oxidant polyphenols, usually present in food and beverages. After cellulose, hemicellulose, and lignin, tannins are considered the fourth most abundant constituent of the plant. According to dietary analysis, the daily intake of tannin in India is 1500-2500 mg. Daily consumption of less than 1.5 to 2.5g tannin does not show any side effects. However, consumption beyond this range leads to diseases like anaemia and osteoporosis and worsens cancer. However, some carcinogenic molecules can induce cancer and cause hepatic cell necrosis.

Polyphenols

Polyphenols are considered vital for life because they maintain body and health throughout life. They act as antimutagenic, anticarcinogenic, antiestrogenic, anti-inflammatory, antiviral, and platelet aggregation inhibitors, which can be useful in minimizing and preventing diseases.

Millet contains more than 50 phenolic compounds, like phenolic acids and their derivatives, flavanols, flavones, and flavanonols, and has a high antioxidant capacity. Soluble phenolic compounds are generally available in the pericarp of the kernel and cell wall consisting of the bound form. Polyphenols can be categorized based on their carbon skeleton as simple phenols, phenolic acids, tannins, flavonoids, lignans, lignins, curcuminoids, coumarins, and stilbenes Polyphenolic content ranging between 502.78- 767.54 mg/100g has been found in pearl millet **(Shahidi and Chandrasekara, 2013).**

Table:2 Anti-nutritional factors

Millets	Anti-nutrients

Finger millets (Ragi)	Tannins, Non-starch Polysaccharides-glucans, protease inhibitors, Oxlates and Phytates
Sorghum (Jawar)	Tannins and Cyanogenic glucoside
Pearl millets (Bajra)	Phytic acid, polyphenols, Alpha amylase inhibitor
Foxtail millets (Kakum)	Phenolic compound and Phytic acid
Porso millets (Chena)	Phytic acid, Polyphenols alpha amylase inhibitors
Barnyard millets (Sanwa)	Tannin and Phytic acid

(Bora, 2014)

5. Conclusion

Millet is staple food for animals and birds. But millet has huge potential for nourishment of population with benefit of low-cost availability and easy cultivation. Millet has wide range of nutrients, anti-nutrients and antioxidants making them useful components of dietary and nutritional balance in foods. Millet's anti-nutrients (such as polyphenols, phenolic compounds, tannins, flavonoids) are not directly related to nourishing to the body but important role in health to curing of diseases such as diabetes, cardiovascular disease, cataract, cancer, inflammation, gastrointestinal problems etc. Millet has specialty among cereal because it is alkaline-forming and gluten-free. Millet is best option for celiac patient, depends on gluten-free diet.

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