**Millets: Nutritional composition, some health benefits and processing**

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In arid and semi-arid parts of the world, millets which are good source of energy are a major food source. Millets contain protein, fatty acids, minerals, vitamins, dietary fibre polyphenols and some of them contain high quantity of essential amino acids especially the sulphur containing amino acids (methionine and cysteine). Bran and germ layers of millets are rich in fibre and phytochemicals which are removed during their processing which is a significant loss. Antioxidants, such as phenolic acids and glycated flavonoids are provided by them. They enhance the viability or functionality of probiotics with significant health benefits that is they are potential prebiotic. A nutritional significance examination for the characteristics and functional properties of different millet cultivars as well as developing value added products from millets is required.

Besides wheat, rise, and maize, Millets are also a major cereal. For people living in hot, dry areas of the world, millets are major food source. Marginal areas under agricultural conditions in which major cereals fail to give substantial yields is where they are mostly grown(Adekunle, 2012).Panicoideae, a grass sub-family is where they are classified with maize, sorghum, and Coix (Job’s tears, Yang et al., 2012). In many underdeveloped countries, Millets are important foods because of their ability to grow under adverse weather conditions like limited rainfall. For millions of people in Africa millet is the major source of energy and protein. Many nutritious and medical functions of millets have been reported (Obilana and Manyasa, 2002; Yang et al., 2012). It can be a important crop during famine as it is a drought resistant crop and can be stored for a long time without insect damage (Adekunle, 2012).

Concern regarding classification of family millet exists, Discrepancies with some references give the family name Gramineae, and others classify it in the family Poaceae. Millets have many varieties and the major four types are Pearl millet (*Pennisetum glaucum*), which comprises 40% of the world production, Foxtail millet, Proso millet or white millet (*Panicum miliaceum*), and Finger Millet (*Eleusine coracana*). The largest seeds are produced by pearl millet and it is the variety most commonly used for human consumption (Mariac et al., 2006; ICRISAT, 2007). Barnyard millet (*Echinochloa spp*.), Kodo millet (*Paspalum scrobiculatum*), Little millet (*Panicum sumatrense*), Guinea millet, Browntop millet, Teff (*Eragrostis tef*) and fonio (*Digitariaexilis*) are also often called millets, as more rarely are sorghum (*Sorghum spp*.) and Job’s tears (*Coixlacrima-jobi*) (ICRISAT, 2007; FAO, 2009; Adekunle, 2012), they all are minor millets. Global millet production reached about 32 million tonnes with the top producing countries being: India (10,610,000), Nigeria (7,700,000), Niger (2,781,928), China (2,101,000), Burkina Faso (1,104,010), Mali (1,074,440), Sudan (792,000), Uganda (732,000), Chad (550,000) and Ethiopia (500,000) (FAO, 2009) in the year 2007. Pearl millet production attained approximately 54% of the global production in 2004 according to FAO 2005. A unique biodiversity component in the agriculture and food security systems of millions of poor farmers is represented by millets in regions such as Sub-Saharan Africa. India is the largest producer of pearl millet (Bhattacharjee et al., 2007) and Pearl millet is an important food across the Sahel. Millets are often ground into flour, rolled into large balls, parboiled, and then consumed as porridge with milk; sometimes millets are prepared as beverages. The primary food of farmers in Gujarat India is Roti, made from pearl millet (FAO, 2009). It is important to explore plants such as millets that are grown locally and consumed by low income households in places like India and the Sahel zone because of the emerging need for the world to feed its growing population. Cereals, in particular, millet based foods and beverages are known worldwide and are still part of the major diet in most African countries (Obilana and Manyasa, 2002; Amadou et al., 2011). The present review summarizes the nutritional composition of millets some health benefits, and the use of millets in the food industry.

**Nutritional composition of millet grains**

The richness of millets in calcium, dietary fibre, polyphenols and protein (Devi et al., 2011) makes them unique among cereals. Significant amounts of essential amino acids particularly the sulphur containing amino acids (methionine and cysteine) are generally present in millets, they also have higher fat contentthan maize, rice, and sorghum (Obilana and Manyasa, 2002). In general, cereal proteins including millets are limited in lysine and tryptophan content and vary with cultivar; most of them contain the essential amino acids as well as vitamins and minerals (Devi et al., 2011; FAO, 2009). Cereal grains constitute a major source of dietary nutrients worldwide (Amadou et al., 2011) and Plant nutrients are largely used in the food industry. Physical, chemical, biological such as fermentation or an enzymatic treatment modify proteins by changing its structure and consequently its physicochemical and functional properties (Lestienne et al., 2007; Amadou et al., 2011b). Table 1 represent the content of different varieties of millet, foxtail, fonio, proso, pearl and finger millets.

**Table 1 Nutrient value of millets (per 100 g edible portion, 12% moisture).**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Crop | Protein(g) | Fiber(g) | Minerals(g) | Iron(mg) | Calcium(mg) |
| Sorghum | 11 | 6.7 | 2.7 | 3.4 | 13 |
| Finger millet | 7.3 | 3.6 | 2.7 | 3.9 | 344 |
| Foxtail millet | 12.3 | 8 | 3.3 | 2.8 | 31 |
| Kodo millet | 8.3 | 9 | 2.6 | 0.5 | 27 |
| Little millet | 7.7 | 7.6 | 1.5 | 9.3 | 17 |
| Pearl millet | 10.6 | 1.3 | 2.3 | 16.9 | 38 |
| Proso millet | 12.5 | 2.2 | 1.9 | 0.8 | 14 |
| Barnyard millet | 11.2 | 10.1 | 4.4 | 15.2 | 11 |

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**Anatomy of a Whole Grain Kernel**

Germ

Germ is the embryo generated after fertilization by pollen sprouts into a new plant and it contains vitamin B and E, antioxidants,phytonutrients and unsaturated fats.

Millets-Nutrients

Millets are a good source of vitamin B, magnesium, antioxidants, manganese,phosphorous and also iron. They have 65% carbohydrates, 9% proteins, 3% fat, and 2- 7% crude fibre and vitamins and minerals and are a good source of essential amino acids except for lysine and threonine but are relatively high in sulphur containing amino acids methionine and cysteine. Millet oil could be a good source of linoleic acid and tocopherols. It is an alkaline forming grain that is gluten-free. Vitamin B such as Niacin, folacin, riboflavin, and thiamine and phosphorus and present in millets that play a key role in energy synthesis in the body. They are a good source of essential fatty acids like linoleic , oleic and palmitic acids found in their free form and monogalactosul, diacylglycerols, diagalactosyl, phosphatdyl serine and phosphatidyl choline in the bound from present in millets.

Types of millets

* Little Millet

It helps in weight loss as it provides essential fats to the body and has high fiber content. It has a good quantity of many nutrients, more than others.

* Proso Millet

Proso millet consists of protein and niacin (Vitamin b3). Traditionally, it is used as recuperative food, especially post pregnancy or illness. It is beneficial in preventing Pellagra condition, which is caused due to the niacin Vitamin B3.

* Pearl Millet

Pearl Millet consists of magnesium which helps in reducing the respiratory problems in asthma patients and helps to reduce the effect of migraine. The insoluble fibre present in pearl millet help in reduction of excessive bile in our system, an excessive bile in our leads to gall stones.

* Foxtail Millet

Foxtail Millet helps in steady release of glucose without affecting the metabolism of the bossy. When people consume foxtail millet, the prevalence of diabetes is reduced and it is also known as healthy heart food due to its good source of magnesium.

* Kodo millet

Kodo millet are traditional food which closely resembles the rice and helps to use in weight loss. It also helps in reducing the joints and knee pain and helps in regularizing the menstruation in woman.

Health Benefits of Millets

1. DIABETES

* Millets reduce postprandial hyperglycaemia by reducing the enzymatic hydrolysis of complex carbohydrates and enzymes like aldose reductase help in prevention of accumulation of sorbitol and reduce the risk of diabetes induced cataract diseases.
* Sorghum based foods have low Glycaemic Index (GI) and reduce the postprandial blood glucose level.
* Consuming millets helps controlling the blood glucose level and also helps in dermal wound healing process with the help of antioxidants.
* Finger millet diets help in dermal wound healing process because of low glycaemic response which was due to high fibre content.
* Finer millets protein inhibits the cataract genesis in humans.
* Millets help in prevention of Type II Diabetes due to their significant levels of magnesium which helps in increasing the efficiency of Insulin and glucose receptors.

1. CANCER

* Sorghum (Millet) has Anti-carcinogenic and anti-mutagenic properties due to the presence of polyphenols and tannins. They can act against human melanoma cells, as well as positive melanogenic activity.
* Millets are rich phenolic acids, phytates tannins and linoleic acid which contain anti-tumour activity and are the antinutrients, help in reducing the risk for colon and breast cancer.
* Incidence of oesophageal cancer is low with sorghum (Millet) consumption therefore lower mortality from oesophageal cancer than wheat and corn.

3. OBESITY

* Obesity which is the biggest emerging problem in India, is associated with several other diseases like Diabetes, Blood pressure and Cardiac problems.
* The dietary fibre content present in millets is 22%. Food rich in dietary fibre improves the bowel function and slows the process of digestion and absorption, thereby reducing the risk of chronic diseases and obesity.
* Millets helps in satiating hunger satisfaction and helps in weight management reducing obesity.
* Good digestion and absorption provided by millets helps in the retention of gastro-intestinal illnesses like ulcers and colon cancers.

4. CVD

* Millets reduce chances of heart attack; reduce blood pressure and the risk of heart attacks of strokes, particularly in the case of atherosclerosis as they are good source of magnesium.
* Millets are rich in Phyto-chemicals which contain phytic acid, they help in lowering cholesterol and preventing cardiovascular disease by reducing plasma triglycerides (Lee, et al., 2010).
* Millets are also a great source of potassium which keeps blood pressure low as it acts as a vasodilator.
* Reducing your blood pressure and optimizing your circulatory system is one of the best ways to protect your cardiovascular health which is done by millets.

5. CELIAC DISEASE

* Celiac disease is triggered by the consumption of gluten and millets being gluten-free help in avoiding them.
* Millets being gluten free have considerable potential in foods and beverages and can meet the growing demand for gluten free foods and will be suitable.

6. AGING

* Methanolic extracts from finger millet and kodo millet inhibited glycation and cross-linking of collagen (Hegde and others 2002). Therefore, there is potential usefulness of millets in the protection against aging.
* Millet grains are rich in antioxidants and phenolics; however, it has been established that phytates, phenols, and tannins can contribute to antioxidant activity important in health, aging, and metabolic syndrome (Bravo 1998).
* The chemical reaction between the aldehyde group of reducing sugars and the amino group of proteins, termed as nonenzymatic glycosylation, is a major factor responsible for the complications of diabetes and aging (Monnier 1990)

6. ANTIMICROBIAL ACTIVITY

* Millet grain fractions and extracts have antimicrobial activity.
* Phenolics in finger millet grain were found to influence its malt quality positively by contributing to attenuation of the fungal load on the germinating grain and malt quality, and high-phenol finger millet types were better than low-phenol types (Sewel and others 2010).
* Protein extracts of pearl millet were highly effective in inhibiting the growth of all examined phytopathogenic fungi.
* Extracts of phenolic acids and other bioactive components have the potential to be used as natural alternatives in food preservation and for therapeutic purposes.

7. PHYTOCHEMICALS

* The polyphenols are the phenolic acids and tannins, flavonoids are present in small quantities; which act as antioxidant and play a role in the body immune system (Chandrasekaran A, et al., 2010).
* Quercetin, curcumin, ellagic acid and various other beneficial catechins can help to clear the system on any foreign agents and toxins by promoting proper excretion and neutralizing enzymatic activity in those organs.
* The antioxidant, metal chelating and reducing powers are shown by the soluble and insoluble bound phenolic extracts of several varieties of millet (kodo, finger, foxtail, proso, pearl and little millets) (Chandrasekaran and Shahidi, 2010).
* Millets are highly nutritious and helps in various health benefits. Millets help in fighting Obesity.

**CHALLENGES AND FUTURE PERPECTIVES**

Although nutritive value and potential health benefits of millet grains are comparable to major cereals wheat, rice, and maize their utilization is still mainly limited to populations in rural areas at the household level due to lack of innovative millet processing technologies to provide easy-to-handle, ready-to-cook or ready-to-eat, and safe products and meals at a commercial scale that can be used to feed large populations in urban areas. Millets are the foods which are the least allergic and which are easily digestible and is the best food for gluten sensitive patients. Millets are plenty with essential amino-acids, fatty-acids and dietary fibre. Diversification of food production must be encouraged both at national and household levels in tandem with increasing yields.

Many healthy nutrients are required for proper functioning of the body and millets have many healthy nutrients. Iron and copper are required for the production of the blood cells and for improving blood oxygenation. They contain phosphorus which helps in controlling blood pressure, fat metabolism, body tissue repair and creating energy (phosphorus is an essential component of adenosine triphosphate or ATP, a precursor to energy in your body. Thereby help in defence activity of the body against diseases. Magnesium in millets can help reduce the effects of migraines and heart attacks. Niacin (vitamins B3 & B6) in millets can help lower the cholesterol. Millet can help lower risk of type 2 diabetes, Fibre from whole grains has been shown to protect against breast cancer and whole grains have been shown to protect against childhood asthma.

The whole world is facing many health challenges because of fibre-less foods. It is also clear to 1000s of patients that all the lifestyle diseases can be made to disappear just by eating millets for breakfast, lunch and dinner and removing refined foods like rice, wheat, refined flours, processed meats, refined oils, packed & ready to consume -kind of foods and milk. It can be one important aspect of therapeutic dietary modification and promoting utilization of minor-grain foods. To produce high-quality products at a commercial scale for urban consumers, there is a need for innovative processing technologies for decortications, milling, and other preparation treatments of millet grain food. And a consistent supply of high-quality millet grains for industrial uses and development of millet cultivars with high essential amino acid content are needed. Evaluation of nutritive value and potential health benefits of millet grains and their fractions in animal and human models should be performed in future research studies to support efforts for promoting their utilization as food.

**CONCLUSION**

Many health-promoting components such as dietary fibre, minerals, vitamins, and photochemical that include phenolic compounds are present in Millets which are comparable to those of major grains and also have several potential health benefits. Novel processing and preparation methods are needed to enhance the bioavailability of the micronutrients and to improve the quality of millet diets. Most of the civilized people have not even heard about millets and much less understand the benefits of millet nutrition. And yet, millet is one of the best-kept secrets of our ancient ancestors. Making food products of millets that deliver convenience, taste, texture, colour, and shelf-stability at economical cost for poor people is needed. In urban areas to open new markets of millets for farmers to improve their income, developing highly improved products is needed.

The aim of this study is to help the people recognize the importance of food and to introduce the millets as a nutritious food, fulfilling the nutritional need of global population and to find ways to consume the millets nutritionally, effectively and to reduce the problems of malnutrition and other health problems. All the millet foods are having significant health benefits, with their rich content of nutrients like fibre which helps in metabolic disorders like Diabetes, Obesity, Cardiovascular diseases etc, their good protein content which helps in child growth and development, with calcium content which helps in the bone development in both children and geriatric people, with good iron content helps in ailing of anaemia and with gluten free characteristics helps the celiac disease patients and helps in gluten insensitivity.

**References**

1. Adekunle, A. A. 2012. Agricultural innovation insub-SaharanAfrica: experiences from multiple stakeholder approaches. Forum for AgriculturalResearch in Africa, Ghana. ISBN 978-9988-8373-2-4.
2. Yang, X., Z. Wan, L. Perry, H. Lu, Q. Wang, C.Hao, J. Li, F. Xie, J. Yu, T. Cui, T. Wang, M.Li and Q. H. Ge. 2012. Early millet use innorthern China. Proc. Nat. Acad. Sci. USA pp.1–5.
3. Obilana, A. B. and E. Manyasa. 2002. Millets. In:P. S. Belton and J. R. N. Taylor (Eds.). pp.177–217. Pseudo cereals and less common cereals: Grain properties and utilizationpotential. Springer-Verlag: New York.
4. Mariac, C., V. Luong, I. Kapran, A. Mamadou, F.Sagnard, M. Deu, J. Chantereau, B. Gerard, J.Ndjeunga, G. Bezancon, J. Pham and Y.Vigouroux. 2006. Diversity of wild andcultivated pearl millet accessions (Pennisetumglaucum [L.] R. Br.) in Niger assessed by  
   microsatellite markers. Theor. Appl. Genet.114:49–58.
5. ICRISAT. 2007. International Crops ResearchInstitute for the Semi-Arid Tropics, 2007  
   annual report. <http://test1.icrisat.org/>Publications/EBooksOnlinePublications/AnnualReport-2007.pdf
6. Bhattacharjee, R. Khairwal, I. S., Bramel, P. J. andK. N. Reddy. 2007. Establishment of a pearlmillet [Pennisetum glaucum (L.) R. Br.] corecollection based on geographical distributionand quantitative traits. Euphotic 155:35–45.
7. FAO. 2005. FAOSTAT. Food and AgricultureOrganisation of the United Nations.www.fao.org
8. FAO. 2009. FAOSTAT. Food and AgricultureOrganisation of the United Nations.FAOSTAT. <http://faostat.fao.org/site/339/>default.aspx
9. Obiana, A. B. 2003. Overview: importance ofmillets in Africa. Published online at[http://www.afripro.org.uk/papers/Paper02Obil ana.pdf](http://www.afripro.org.uk/papers/Paper02Obil%20ana.pdf)
10. Amadou, I., L. Guo-Wei, S. Yong-Hui, O. S.Gbadamosi, M. T. Kamara and J. Sun. 2011b.  
    Optimized Lactobacillus plantarum Lp6 solidState fermentation and Proteolytic hydrolysis  
    improve some nutritional attributes of soybeanprotein meal. J. Food Biochem. 35(6):1686–1694.
11. Devi, P. B., R. Vijayabharathi, S. Sathyabama, N.G. Malleshi and V. B. Priyadarisini. 2011.  
    Health benefits of finger millet (Eleusinecoracana L.) polyphenols and dietary fiber: areview. J. Food Sci. Technol. DOI:10.1007/s13197-011-0584-9
12. Chandrasekara, A. and F. Shahidi. 2010. Content of insoluble bound phenolics in millets and their contribution to antioxidant capacity. J. Agric. Food Chem. 58:6706–6714.