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Millets: A Potential Functional Food

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Abstract: Millets are one of the importantcrops grown for food and fodder in areas with such agricultural conditions that majority of cereals either do not give good yield or completely fail to grow. Millets are excellent sources of nutrients and energy. They possess good resources of dietary fibre, protein, unsaturated fatty acid, vitamins, minerals and bioactive phytochemicals. Millet grain is constituted of high content of carbohydrates, major portion of which is composed of non-starchy or slowly digested polysaccharides making them a good dietary component for diabetic patients. The protein content of millets contains good amount of indispensable amino acids particularly sulphur possessing amino acids like cysteine and methionine. Gluten protein is absent in most varieties of millets, so food items prepared using millets are boon for patients suffering from Celiac disease.Millets are also good source of phytochemical showing anti-cancer, anti-mutagenic, anti-oxidant and anti-microbial properties. These properties prevent number of health disorders like cancer, ageingand also help in lowering the blood cholesterol levels.
Keywords: Millets, Functional food, Health Benefits, Sorghum

1. Introduction

Millets comprise group of grasses with small seeds which are primarily used around the world to serve the purpose of cereal crops for human food or fodder for animals. Following are the major types of millets

Sorghum

Vernacular Name in Hindi: Jowar
Botanicalname:*Sorghumbicolor*(L.)Moench
Family : Poaceae
Common name: Broom corn

Sorghum is a summer season crop with variety of names like great millet, guinea corn, jowar, etc. There are four major classes of sorghum based on pericarp colour and thickness, pigmentation of testa, endosperm colour and type. These four groups are: grain sorghum, forage sorghum, grass sorghum and Sudan sorghums (Macrae*et al*., 1993).

Finger millet:

Vernacular Name in Hindi: Ragi

Botanical name :*Eleusinecoracana*(L.)Gaertn.
Family : Poaceae
Finger millet is also known as Ragi or mandua in India, is an annual grass, grown mainly for its grains (FAO, 2012). The inflorescence has many spikes resembling fingers (De Wet, 2006). Its grains are easily digestible and very nutritious. Sprouted form of grains is good for infants. It is also used in making alcoholic beverage in Ethopia (areki), by-products of the process are used to feed livestock (FAO, 2012).

Pearl millet:
Vernacular Name in Hindi: Bajra
Botanical name :*Cenchrusamericanus*(L.)Morrone
Synonym :*Pennisetumglaucum*(L.)R.Br.
Family:Poaceae
This variety of millet is commonly known as bajra, is a crop of areas characterized by high temperature, scarcity of water and less fertile land. It performs well in soils with high salinity or low pH. It can also tolerance condition of high salinity. So, climatic changes leading to drought raises food security issues. Pearl millet, on the other hand, will help in waiving off such food security problems (Monika *et al*., 2020).

Proso Millet:
Vernacular Name in Hindi: Barre
Botanicalname:*Panicummiliaceum*L.
Family:Poaceae
Proso is an annual grass of dry climates. It is well suited crop or organic farming, since it has low demand for fertilizers and lack any diseases. It is used in crop rotation as intercrop between two pesticide and water demanding crops (Banhur*et al.,* 2010).

Kodo millet:
Vernacular Name in Hindi: Kodra/Kodo
Botanicalname:*Paspalumscrobiculatum*L.
Family :Poaceae
It is a crop of damp habitats. It is very nutritious, possess high protein, lecithin, B-complex vitamin, minerals and fibre content. It is very safe also due to low fat and no gluten content.

Foxtail millet:
Vernacular Name in Hindi: Kangni
Botanicalname:*Setariaitalica*(L.)P.Beauv.
Family :Poaceae
Foxtail millets grow at around 2000 meters height from sea level. It can tolerate drought but not water logging condition.

Barnyard millet:
Vernacular Name in Hindi: Sanwa
Botanicalname:*Echinochloacrus-galli*(L.)
Family :Poaceae
It is generally used for both food as well as fodder. Nutritionally, it has low content of carbohydrates which is even digested slowly making it suitable for patients with diabetes. But, the content of proteins and fibres is high.

Little millet:
Vernacular Name in Hindi: Kutki
Botanicalname:*Paniculamsumatrense*Roth
Family :Poaceae
Little millet is also known askutki in India, is grown in India up to heights of 2100 m. As compared to other millets, little millet's seeds are smaller in size. It can tolerate the conditions of drought as well as water logging.

2. Nutritional profile

Nutritionally, millet grains are good source of protein, vitamins, minerals including trace elements, phytochemicals and energy (Habiyaremye*et al*., 2017). Theycontainaround 65% carbohydrate, providing a good source of energy (Table 1).Major portion of carbohydrates is made up of non-starchy polysaccharides or dietary fibre. The fibre constituentof millets helps in preventing constipation, reducing risk of cardiovascular diseases by reducing level of blood cholesterol and control the condition of diabetes by slow release of glucose during digestion (Anju & Sarita, 2010 and Gupta *et al*., 2017). Millets contain a moderate amount of protein, with finger millet having the highest protein content among them.Millet grains possess rich reserve of vitamins, both water soluble and fat-soluble groups and minerals also (Table 2). Finger millets have highest content of calcium as compared to the other cereals (Thompson, 1993). They also contain essential minerals such as calcium, iron, magnesium, phosphorus, and potassium.Millets are rich in antioxidants which help in combating oxidative stress in the body.Different varieties of millets are rich resource of phytochemicals like polyphenols, flavonoids, lignans, sterols, pigments, tannins and phytates (Ramachandra *etal*., 1977 and Gul*et al.,* 2014). These bioactive plant chemicals contribute to the antioxidant properties and helps in delaying ageing and other metabolic diseases (Bravo, 1998). Phytate constituents of millets are associated with anticancer as well as cholesterol lowering property (Coulibaly*et al.*, 2011).

Thus, the nutrient profile makes millets a complete food,which can even be used to replace conventional cereals in diet, snacks and baby food. Replacement of routine cereals with millets will also bring food security in developing and under-developed countries.

3. Health Benefits of Millets

Millets have good potential in maintaining sound health. Routine consumption can greatly decreasechances of heart disease, occurrence of diabetes, enhances functioning of digestive system, reduces risk of occurrence of cancer, cleanses or detoxifiesthe body, etc., (Manach*et al*., 2005; Chandrasekara and Shahidi, 2012).

Cardiovascular diseases: Cardiovascular diseases are the major cause of disability and death round the world (Kaur, 2021). Millets are rich source of potassium and magnesium. Both these minerals play important role in maintaining heart in good health by lowering the blood pressure.Potassium lowers the risk of cardiovascular problems by its action of vasodilation while magnesium reduces chances of heart stroke in atherosclerosis.The high content of fiber in millets helps in removing LDL thereby lowering the cholesterol in the system. The separate studies on rats fed with barnyard millets, finger millets and porso millets have shown to lower the concentration of plasma and serum triglycerides in hyperlipidemic rats (Lee *et al.,* 2010).Similarily, hamsters fed on grain sorghum lipid extract (GSL) showed reduced levels of liver cholesterol partly by inhibiting absorption of cholesterol due to presence of plant sterol in the grain extract (Carr *et al.*, 2005).

Diabetes: Diabetes mellitus is an endocrine disorder which occurs due to lesser production of hormone insulin in the body (Saleh *et al.,* 2013). Therefore, the disease is characterised by changes in the metabolism of carbohydrates, lipids and proteins resulting ina condition of hyperglycemia.Sorghum and other millets contain high content of slow digestible starch (SDS), which prolongs breakdown and thus absorption of carbohydrates in the body and thus helps to control the condition of diabetes and hyperlipidemia (Kumari and Sumathi, 2002; Asp, 1994).In 2010, National Institute of Nutrition (ICMR) and the Indian Institute of Millets Research, Hyderabad together evaluated sorghum-based items of food for their Glycemic Index (GI). The outcomes showed low glycemic index of sorghum food items. High level of magnesium in millets prevent occurrence of diabetes by increasing the efficiency of glucose receptors and insulin.Further, themillets reduce the risk of occurrence

of diabetes due to presence of tannins andphenolic compoundswhichcontrol the sudden rise of blood glucose(Montonen *et al.,* 2003). Property of inhibition of alpha amylase along with high fibre content of finger millets reduces digestion and absorption of starch (Kumari and Sumathi, 2002).The strong inhibitory properties against α-glucosidase and pancreatic amylase were shown by phenolic compounds found in seed coat of millets (Shobana *et al.,* 2009). Likewise, foxtail millet, Proso millets, peral millets and Barnyard millets have excellent anti-diabetic property (Sireesha *et al.,* 2011; Park *et al.,* 2008; Ugare*et al.,* 2011).

Gastrointestinal Disorders: Improved digestion can enhance nutrient retention as well as reduces the incidence of gastrointestinal problems like gastric ulcers and cancer of colon. High fibre content of millets can be helpful in eliminating problems like constipation, gas, abdominal bloating and cramping. Celiac disease (CD) is a genetic disease, in which patients cannot tolerate gluten protein of cereals like wheat. The reaction of immune system against gluten causes severe abdominal cramps in the effected people (Catassi and Fasano, 2008). Thus, they have to rely on gluten free diet. Sorghum is gluten freeso, it can serve as healthy option of diet for patients suffering from celiac disease as it is gluten free (Carolina *et al.,* 2007). Millets being gluten free, have great potential in foods industry as it can contribute in meeting the increasing demand for gluten free foods (Taylor and Emmambux, 2008).

Cancer: Millet grains are rich in fibre, phenolic compounds, tannins and phytate (Thompson, 1993). These nutrients play major role in reducing the risk of cancers of colon, oesophageal and breast (Graf and Eaton, 1990). Anti-cancer and anti-mutagenic properties are exhibited by phytochemicals present in millet sorghum(Grimmer *et al.,* 1992) which can be effective against melanoma cells (Gomez-Cordovez *et al.,* 2001).

Detoxification (Anti-oxidant Properties): Many antioxidants are found in millet which exerts beneficial action on body by neutralizing free radicals and cleaning up other kinds of toxins. These free radicals and toxins can be the root cause of cancer. Quercetin, ellagic acid and curcumin can help in clearing any toxins from the body by enhancing proper excretion (Tsao R, 2010).The antioxidant potential is shown by the phenolic extracts of many varieties of millet like kodo,proso, foxtail, pearl, finger and little millets. More than 50 phenolic acid compounds were identified in different millet varieties by using the techniques of HPLC and HPLC-tandem MS (Chandrasekara and Shahidi, 2011a). Thus, millet grains mayserve as functional food and nutraceuticals as are good sources of natural forms of antioxidants.

Obesity: The problem of Obesity is increasing worldwide and is directly linked with many diseases like diabetes and cardiovascular diseases. Consumption of high fibre in diet can decreases the chance of obesity (Alfieri *et al.,* 1995). Foods with more dietary fibre enhance the function of large bowel and slowsdown the process of digestion and absorption, thus greatly reducing the chance of chronic problems. Sorghum is very rich source of dietary fibre and add bulk to the diet and has good water holding capacity which helps in hunger satisfaction and reducing the risk of getting obese.

Antimicrobial activity: Millet grains possess many secondary plant metabolites which exhibit wide spectrum of antibacterial and antifungal property (Xu *et al.,* 2011). Protein extract prepared from pearl millets showed high level of antifungal activity against *Rhizoctonia solani*, *Macrophominaphaseolina,* and *Fusarium oxysporum* (phytopathogenic fungi) (Radhajeyalakshmi*et al.,* 2003). Inhibitory action against proliferation of different bacteria like *E. coli*, *B. cereus, L. monocytogenes, S. aureus, S. pyogenes, S. marcescens, P. mirabilis*, *P. aeruginosa*, *K. pneumonia*, and *Y. enterocolitica* was shown by phenolic and flavonoids of finger millets (Banerjee *et al.*,2012).Therefore, antimicrobial property of millet grains can a potential pharmaceutical option for treatingdifferentmicrobial infections.

Nutrient Deficiency Diseases:

Whole grain of millets like sorghum, finger millet and pearl millet are converted into flour without any prior need of dehusking and polishing. Thus, vitamins and minerals are retained

in the flour. The inherent components of seed coat like important dietary fibres and polyphenols, contributing to health benefits, are also retained. Dehusking and polishing of cereal grains do not significantly impact macronutrients content but it importantly affects micronutrient content like methionine, lysine and threonine (Slavin and Slavin,2004). Millets are highly nutritious and have been a staple food in various cultures for centuries. They significantly play part in combating nutritional deficiency problem. Millets are very nutritious and aid alleviate following deficiencies:

Malnutrition of protein: Food ingestion lesser than body requirement for a prolonged time span, particularly in children, causes conditions like kwashiorkor and marasmus(Awadalkareem et al., 2008). Whereas, over intake of food than body requirement causes obesity and related disease. Both the conditions, under nutrition as well as over nutrition, enhances mortality chances. Foxtail millets and proso millet possess proteins values higher than conventional grains like wheat and rice (Table 1)

Beriberi: Deficiency of water-soluble vitamin, thiamine, is the root cause of beriberi. This B-group vitamins are found in the outer layer of grain called aleurone. Extensive polishing of grain removes this outer layer and prolonged intake of polished rice leads to development of beriberi. Whole grain millets are rich in vitamins as they are not polished and prove beneficial in preventing incidences like beri-beri (Table 2).

Pellagra: Deficiency condition of amino acid Tryptophan and vitamin Niacin is known as pellagra. The episodes of pellagra were noticed in communities using maize as staple food. Maize is deficient in tryptophan and latest milling methods makes it deficient in vitamin niacin as well. Good amounts of niacin and proteins is present in millets, making it suitable for overcoming conditions of pellagra.

Anaemia: The condition of iron deficiency is associated with progression of anaemia in young children and expecting women. There is limited availability of iron in polished rice, furthermore its absorption is greatly decreased by the occurrence of phytic acid. Millets particularly pearl millet and finger millet, which are also the whole grain millet are rich source of mineral like iron (Table 2).

Neural tube defects: Deficiency of folic acid rapidly effects dividing cells as they have greater demand of this vitamin. Clinically, this condition is called megaloblastic anaemia and is associated with defect in bone marrow. Supplementation of folic acid during first trimester of conception significantly lessens the incidence of neural tube defect. Millets with minimal processing retain most micronutrient and provide balanced nutrition for humans (Table 2). Most varieties of millets possess excellent amount of folic acid as compared to rice and wheat (Gopalan et al., 1996).

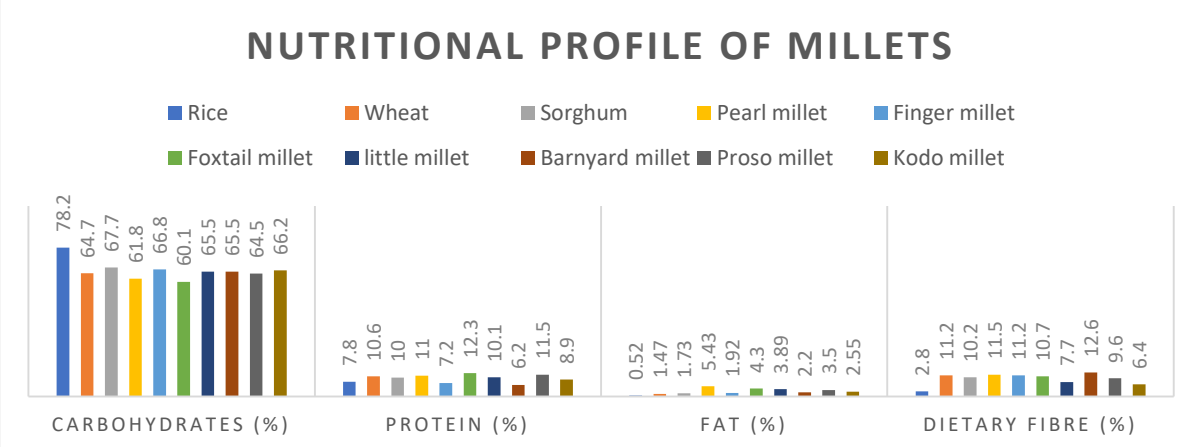

Table 1: Nutritional profile of different millets. (Source: Indian Food Composition Tables-NIN, 2017)

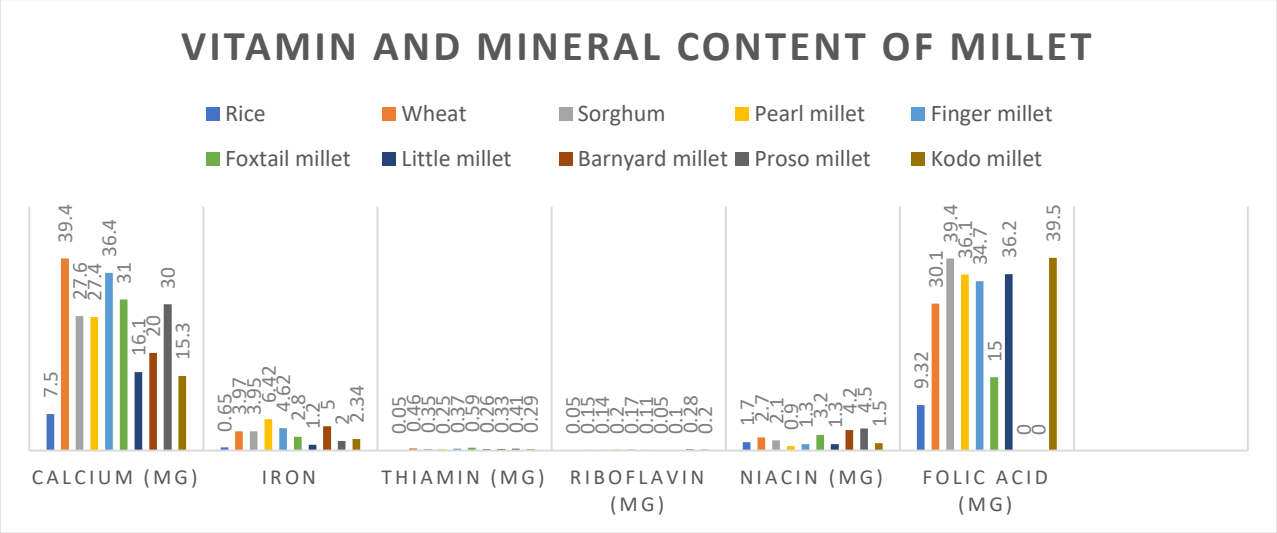

Table 2: Vitamin and mineral content of different millets. (Source: Indian Food Composition Tables-NIN, 2017)

3. Conclusion:

Millet is a wonder crop with extensive nutritional profile thereby making it a functional food. It has great adaptability towards diverse environmental conditionsand thereby, it is a crop for underprivileged people as it can be grown with lesser material inputs and thus costs less. It also helps to overcome the condition of food security issues as it can be grown in areas with extreme weather and soil conditions. Thus, the lesser cultivated and used millets can give greater benefits if brought more under cultivation and use.

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