

# ROLE OF MILLETS IN ENSURING FOOD AND NUTRITIONAL SECURITY

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## ABSTRACT

*Millets are the small seeded grains of family Poaceae. They are able to grow on less fertile soils, have low water requirement and short maturity time. They are also nutrient dense in comparison to rice, wheat and maize. Their proteins are free from gluten and hence can be used an alternative to wheat flour for celiac patients. They are rich source of dietary fibre and phytochemicals like phytic acid and ferulic acid. Dietary fibre helps in the growth of probiotic microorganisms and hence millets can be used as a potential prebiotic source. Dietary fibre also reduces the glycaemic index of the food. Phytic acid helps in the reduction of cholesterol and also reduces the cancer. Ferulic acid is an antioxidant and exhibit strong free radical scavenging and anti-inflammatory activity. Nowadays, the millets have been use widely for the development of functional foods.*

**Keywords:** *Millets, drylands, phytochemicals, health benefits*

## 1. INTRODUCTION

Recent developments in science and technology have modernized the agriculture and the production of food grains is increased by several folds. The world total cereal grain production was 2719 million tonnes in 2018-19 and that was enough to feed world population. But on the contrary, the resources are being exploited and the over production is resulting in nutrient deficient soils. According to a report of International Crop Research Institutes on the Semi-Arid Tropics (ICRISAT) 6.5 million hectares of dryland area and due to climate change this area has been increased by 10 per cent. Drylands now constitute 40% of the world's land area and approximately 2.5 billion people live in these areas. Drylands house 42% malnourished children of Asia and 27% malnourished children of Africa. We can no longer exploit the fertile soils as the overproduction has reduced the nutrient density of cereal grains. We need to look for alternate cereals and try to make our drylands productive (Kumar et al., 2018). Millets possess a huge potential to solve this problem as they have the ability to grow on poor soils, require less irrigation and are possess better nutritional properties in comparison to rice and wheat. The millets are also known as famine grain owing to their productivity under extreme conditions and resistance to pests and diseases (Saleh et al. 2013). These cereals also requires micro-dosing of fertilizers when compared to major cereals like rice and wheat.

Millets constitute the staple diet in many parts of Asia and Africa since ancient time. Millets are also rich in phytochemicals and possess several health benefits such as lowering blood glucose level, reduces chances of tumor development, lowers the cholesterol and reduces cardiovascular diseases. Strong antioxidant properties of millets help in the prevention of cancer (Anand et al., 2017; Sharma et al., 2019). Dietary fibre in the millets delays the gastric emptying and controls the rate of fat absorption (Gupta et al. 2012). The

role of millets in designing the modern foods like multigrain flour, composite bakery foods, drinks and gluten-free foods is also well known (Kumar et al. 2020 (a); Kumar et al., 2020 (b)). The present review deals with the nutritional composition, health benefits and value added products based on millets.

## 2. MAJOR MILLETS

### *Pearl millet*

Pearl millet (*Pennisetum glaucum*) is native to Africa (Hannaway and Larson, 2004) and is widely grown in India. Earlier, it was used as a forage crop but was later (4000 to 5000 years ago) adopted as a food crop. Presently, it has been cultivated across Africa and Asia and is known by various common names like Bulrush millet, *Amabele*, *Bajra*, *Babal*, *Nyalothi*, *Ntweka*, *Muvhoho*, *Leotja*, *Mhunga* etc. It can be grown on low fertile soils with a low rainfall of 200-600 mm. It grows well in altitude of 2000-2700 meters (Hannaway and Larson, 2004). It can tolerate high temperature and can survive the conditions which other cereals cannot. Pearl millet has two major varieties i.e. dwarf and tall. Dwarf variety is leafier and is used for grazing and the latter variety is a good producer of grains (Nambiar et al. 2010). The nutritional composition of millets is provided in Figure 1 and Table 1.

### *Finger millet*

Finger millet (*Eleusine corcana*) is considered to be originated in Ethiopia and is believed to be introduced in India about 4000 years ago. It is mainly known as *ragi* in India but various other local names like *koda*, *mandal*, *mandua*, *nachanior* *nagli* are also prevalent in the different parts of the country. It has high nutritional value and phytochemical content which makes it a super cereal which can be used for the development of functional foods. It is a good source of proteins and has well balanced amino acid profile (Shimelis and Mulugeta 2009). It is a good source of essential amino acids like methionine, cystine and lysine. It is low in fat (1-1.5 g/100g) but almost 74.4% of fatty acids present in it are unsaturated. The major fatty acids present in finger millet are oleic, palmitic and linolenic acids. It is a good source of minerals and contains the highest calcium content among cereals. It is also a good source of phosphorus, iron, potassium, Vitamin B1, B2 and B3. It is also a rich source of dietary fibre. Major soluble polysaccharides found in *ragi* are arabinose and xylose. The seeds are also rich in phytochemicals such as phytic acid and ferulic acid.

### *Proso millet*

Proso Millet (*Panicum miliaceum*) is also known as common millet, hog millet, broom millet, yellow hog, black seed proso millet and white millet (Sheahan, 2014). It is native to Manchuria and was introduced to Europe and India about 3000 years ago. It can grow in many soil and climatic conditions. It grows well from 1200 meters to 3500 meters. It has a short maturing time of 60-90 days. Nutritionally, proso millet is comparable to wheat. It has a carbohydrate content of 70g/100g. The fat content is 2nd highest among millets i.e. 4.0g/100g and the predominant fatty acids in the free lipids are linoleic, oleic, and palmitic acids (Amadou et al., 2013). The protein content is 10.6 g/100g. The protein of proso millet is gluten free and can be used for foods for people with gluten intolerance or celiac disease. It is also a good source of Vitamin B2, B3 and B9. It is also rich in fibre and minerals i.e. 12g and 2.9 per 100g, respectively. Proso millet is also a good source of dietary fibre and has a lower glycaemic index (Park et al., 2008).

### *Foxtail millet*

Foxtail millet (*Setaria italica*) is native to China. It is considered the first domesticated millet and its cultivation was started about 7000 years ago. Other names like foxtail bristlegrass, Italian foxtail, Italian millet, German millet and Siberian millet are also prevalent for this millet. It likes cold draughtier regions (Koch, 2002). It is cultivated in an altitude range of sea level to 2000 meters. It is also grown in India, Russia, Africa and the United

States. It can grow in sandy to loamy soils with pH from 5.5 to 7. It exhibit tolerance to salinity and can grow in saline soils (Krishnamurthy et al., 2014). Foxtail millet contains 75.2g/100g of carbohydrates, 10-12% proteins and 2.38-5 % fat. It produces 351 kcal of energy (Amadou et al., 2013). However, a low carbohydrate content of (60.9 g/100g) has been also reported by Ballolli et al., (2014). It is also a rich source of fibre and minerals. The fibre content is 8g/100g and 3.3g/100g of minerals. It is an excellent source of zinc (40.4 ppm) and iron (27.19 ppm) among millets (Chandel et al., 2014).

#### *Barnyard millet*

Barnyard millet was derived from wild millet barnyardgrass (*Echinochloa crusgalli*) and was domesticated about 4000 years ago in India and Japan. There are two species of barnyard millet i.e. *E. frumentacea* (Indian barnyard millet) and *E. esculenta* (Japanese barnyard millet). It is cultivated mainly in India, China and Japan as a substitute for rice (Sood et al., 2015) and is known with various names like Japanese millet, white millet, black millet, alkali millet, water grass, duck millet. It is the fastest growing of all the millets. After sowing, the grain is matured in 45 days under favourable conditions. The millet best grows in sandy soil with 4.6-7.4 pH values but has adapted to soils with low pH value of 4.5 and salinity of 2,000–3,000 parts per million (Farrell, 2011).

The barnyard millet grain contains about 49-65% carbohydrates (Sood et al., 2015). The carbohydrates are mainly composed of dietary fibre. The high content of dietary fibre helps in the prevention of constipation, reducing glycaemic load and lowering of blood cholesterol level. It has the highest content of crude fibre (14.7g/100g) and minerals (4.0g/100g) among all the millets. The iron content (18.6 mg/100g) of Barnyard millet is higher among all the millets and protein content is from 11.1% to 13.9%.

#### *Health benefits*

Millets are rich source of vitamins, amino acids, phytochemicals and minerals (Anju and Sarita, 2010) abode several health benefits like prevention of diabetes, cardiovascular diseases and cancer. The beneficial effects of millets in diabetics are attributed to the presence of phenols and dietary fibre. Phenols partially inhibit the amylase and  $\alpha$ -glucosidase activity and controls blood glucose levels in the blood (Shobana et al., 2009). The polyphenols are also reported to have platelet aggregation inhibitory activity. The dietary fibre is an important phytochemical component of millets. The millets contain as high as 13-38% of total dietary fibre that could be considered in the management of disorders like diabetes mellitus, obesity, hyperlipidemia, etc. The glycaemic load lowering effects of barnyard millet is highest among all the millets (Kumari and Thayumanavan 1998). Foxtail millet exhibits antihyperglycaemic and antilipidemic activities. An aqueous extract of 300 mg of foxtail millet per kg body weight of rats exhibited 70% reduction in blood glucose level in streptozotocin induced diabetic rats (Sireesha et al., 2011). Millets are also a good source of carotenoids (78-366mg/100g) and possess higher antioxidant capacity (Devi, 2014). The antioxidant activity of millets is also attributed to their tocopherol content.

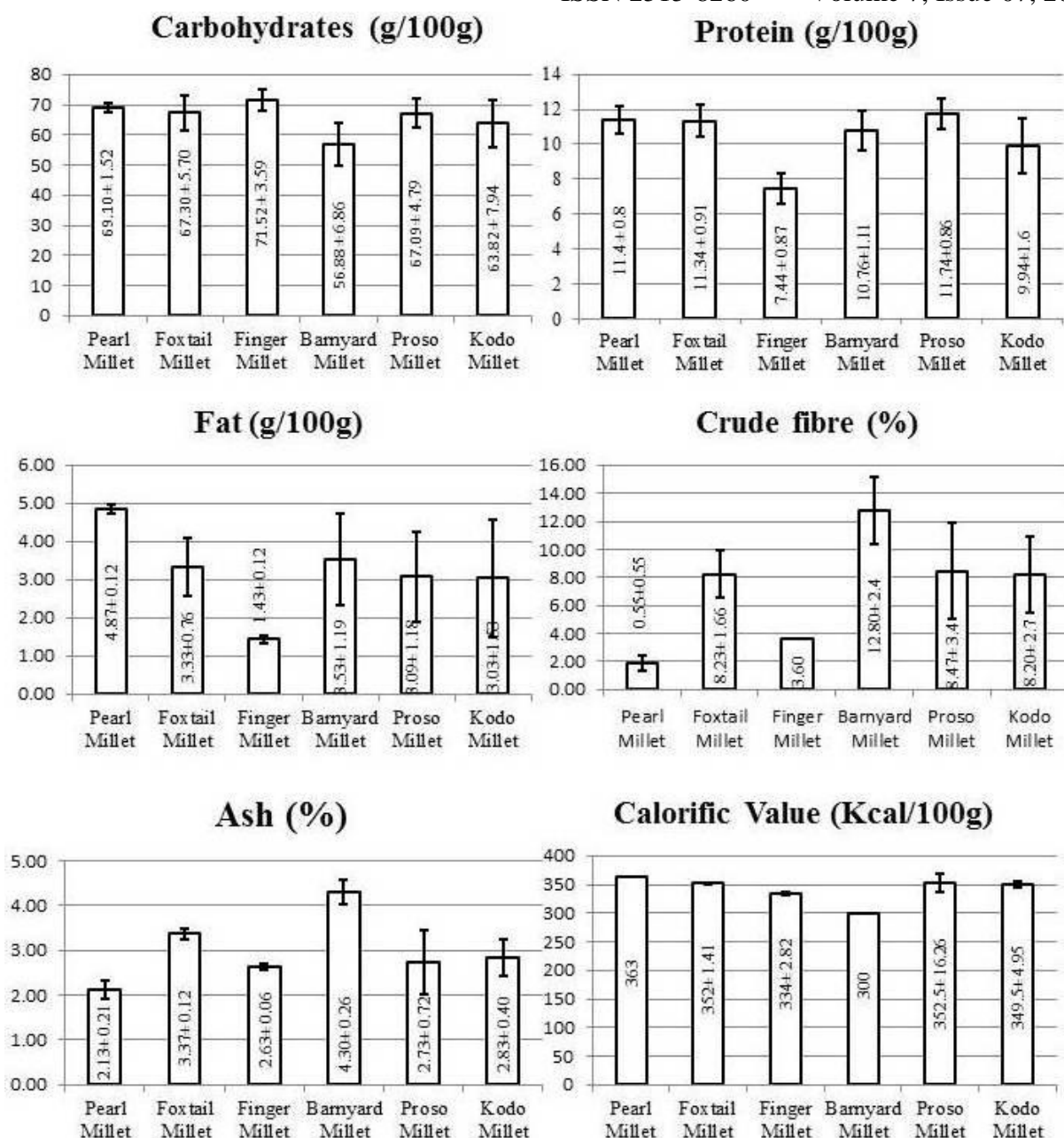


Figure 1: Nutrient Composition of different millets (Source: Kumar et al., 2108)

Table 1: Micronutrient composition of different millets (mg/100 g)

Millet	Calcium	Iron	Phosphorus	Zinc	Thiamine	Niacin	Riboflavin
Pearl millet	35±8.9	10.3±7.0	339	-----	0.3±0.1	1.11±1.3	1.48±1.9
Foxtail millet	31±11	3.5±1.2	300	60.6	0.6	0.55±0.6	1.65±2.2
Finger millet	348±3.5	4.27±0.6	250	36.6±3.7	0.4±0.1	0.80±0.9	0.60±0.7
Barnyard millet	18.33±6	17.47±2	-----	57.45±1.9	0.33	0.10	4.20
Proso millet	10±3.5	2.2±1.2	200	-----	0.41	4.54	0.28

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Kodomille t	32.33±4. 6	3.17±1. 3	300	32.7±2.2	0.15	0.09	2.0

### *Millet based food products*

Millet has been named nutri-cereals and now they are used either for the fortification of existing products or the development of novel food products. This section discusses some of the recent developments in the millet based food products.

### *Alcoholic beverages*

A commercial gluten free whiskey known as Koval single barrel millet whiskey is also produced using millets. Many researchers have also optimized millets for the preparation of millet based alcoholic beverages (Kumar et al., 2015; Kumar et al., 2013; Khandelwal et al., 2012). A blend of finger millet and barley in the ratio of 68:32, kilning temperature of 50°C and slurry ratio of 1:7 was optimized for the production of beer (Kumar et al., 2015). Kumar (2013) refined the traditional technology of sur (a finger millet based traditional alcoholic beverage of Himachal Pradesh) production. A process for beer production was optimized using 70% of malted finger millet grains and 30% of maize grits. Khandelwal et al., (2012) investigated the suitability of the finger millet and pearl millet for the development of low alcoholic beverages. It was concluded in the study that finger millet based beverages had more acceptability as compared to pearl millet based beverages.

### *Bread*

Millet fortified biscuits has been reported by various researchers (Devani et al., 2016, Rozylo, 2014, Singh and Mishra, 2012). Devani et al., (2016) reported that substitution of wheat flour with finger millet flour up to a concentration of 20% do not have any adverse effect on the quality of bread. Fortification with millets also increased crude fibre, ash and calcium content of bread. Another study reported that in the bread preparation wheat flour can be successfully replaced up to 30 percent with millet flour. Wheat flour can be substituted up to 61% with barnyard millet flour but in that case we need to add gluten from external sources (Ranasalya and Vishvanathan, 2014; Singh and Mishra, 2012).

### *Functional beverages*

Kumar et al., (2020) optimized a process for the development of finger millet, oats and double toned milk-based functional beverage. Process optimization for preparation of functional drink was carried out in two parts. In the first step malt drink was prepared using malted finger millet grains and oat groats. Both the cereals were ground to coarse flour and mixed in ratios ranging from 90:10 to 50:50; three times of potable water was added and the mixture was mashed. A 40:10 of finger millet malt and oat groats was selected for the preparation of malt drink on the basis of sensory scores. Second optimization was carried using response surface methodology. Malt drink and double toned milk in the ratio of 60:40 was selected for the preparation of functional beverage. The prepared beverage had an overall sensory acceptability similar with cattle milk. The product was low in fat, cholesterol and lactose. Fortification with millets added the dietary fibre and  $\beta$ -glucan to the milk and also enhanced the total phenols and antioxidant activity of the beverage. Further, the effect of the addition of natural flavourings i.e. rose syrup and marigold powder was also studied by Kumar et al., (2020). The addition of the rose syrup was reported to enhance the overall acceptability of the beverage.

### *Millet based probiotic beverages*

A millet-based probiotic food was developed by Stefano et al., (2017). For the preparation of beverage 800 mL of milk was added to 152 g of millet flour and the mix was boiled and stirred constantly at a boil for 15 minutes. The mix was cooled, inoculated with

bacterial culture and 9 hours and 12 hours. Two log cycle increases in the population of *L. rhamnosus*GR-1 and 3 log cycle increase was observed in *S. thermophilus* after fermentation. Kumar (2017) studied the growth behaviour of *Lactobacillus acidophilus* NCDC14, *Lactobacillus casei* NCDC297, *Lactobacillus rhamnosus* NCDC347 with or without co-culture *Streptococcus thermophilus* NCDC74 in nutri-cereals based beverage. The beverage was inoculated with 1% and 5% of culture and it was observed that an incubation time of 6 hours produced the most desirable beverage. There was a three log cycle increase in the cell viable count after 6 hours of fermentation. Among the studied strains *L. acidophilus* produced most desired sensory characteristics.

### 3. CONCLUSION

The increased per hectare production of cereal grains has resulted in the loss of nutritional value of food grains. This is the time when we should reduce burden on our fertile soils and should try to make our drylands productive. Millets can play a major role in the food as well as nutritional security. In addition to this we need to develop novel methods for the food utilization of the millets.

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