ISSN–0974–0759 | ●●● Success Story ●●● |Visit us : www.researchjournal.co.in|

Nutri-cereal pearl millet: Importance and challenge ahead

Nirupma Singh[1], Aarti Kumari[1], S.P. Singh[1] **and** Anita Meena[2]
[1]Division of Genetics, ICAR-IARI, New Delhi, India
[2]ICAR- Central Arid Horticulture Institute, Bikaner (Rajasthan) India
(Email: nirupmasingh@rediffmail.com)

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is a cross-pollinated diploid annual plant with a large genome size (2450 Mbp). The crop is well adapted to agricultural areas that are affected by severe drought, poor soil fertility, and high temperature. Because of its resilient behaviour, it is grown in about 31 million hectares worldwide and covers more than 30 countries located in the arid and semi-arid tropical and subtropical regions of Asia, Africa and America and Australia. Although the majority of crop area is in Asia (10 million ha) and Africa (18 million ha), now pearl millet cultivation is being expanded in some of the non-traditional areas, with Brazil having the largest area (about 2 million ha). Pearl millet is the most widely cultivated cereal in India after rice and wheat. In India, it is grown in 7.38 million hectares with grain production of 9.13 million tonnes and productivity of 1237 kg/ha. The major pearl millet growing states are Rajasthan, Gujarat, Maharashtra, Karnataka, Madhya Pradesh, Uttar Pradesh and Haryana which report about 98 per cent of pearl millet acreage in country.

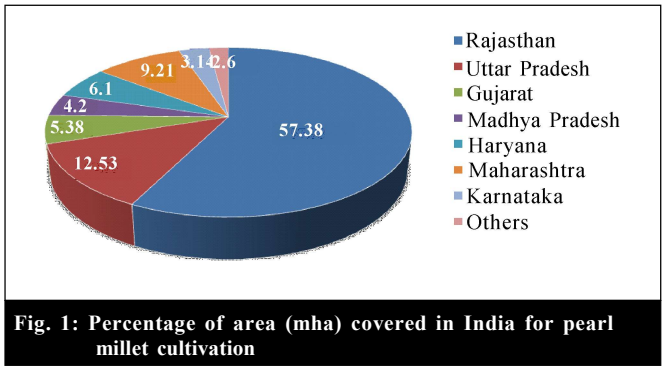

Fig. 1: Percentage of area (mha) covered in India for pearl millet cultivation

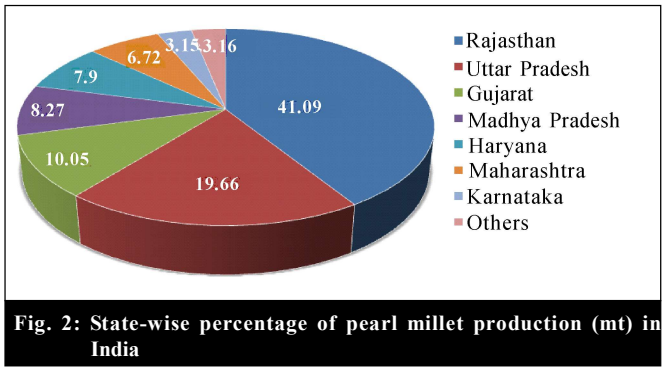

Fig. 2: State-wise percentage of pearl millet production (mt) in India

Power punch of pearl millet: In India, Pearl millet is the third most important cereal crop after rice and wheat. It is a nutrient- dense crop with calorific value of 2900 kcal/kg, grown primarily for human consumption in Asia and Africa. It is one of the cheapest sources of protein, iron and zinc and contains high amount of fibre, vitamins and minerals. Its immense nutritional properties are recognized by Government of India and put it in a basket of 'Nutri Cereal'. Its energy deliverable of (361 Kcal/ 100g) is comparable with sorghum (349 Kcal/100g), wheat (346 Kcal/100g), rice (345Kcal/100g) and maize (325Kcal/ 100g).

Carbohydrates are the main component of cereals with average content of 72.2 per cent in pearl millet grains which is higher than wheat (68.8%), lower than rice (84.9%) and maize (78.1%).While, the average dietary fibre content (1.2g/100g) in pearl millet grains is 7.8 per cent higher than rice. The consumption of high fibre reduces inflammatory bowel diseases, reduce symptoms of depression and heart problems.

Another major component in pearl millet grains are proteins. The grains contain 11.8 per cent protein comparable to wheat but higher than maize (9.2%) and rice (8.6%). With low prolamin fraction, pearl millet is gluten free grain and is the only grain that retains its alkaline properties after being cooked which is ideal for people with gluten allergy. Pearl millet has high levels of amino acid, glutamic acid (23 g/100g protein) known to be a neurotransmitter or precursor of γ-aminobutyric acid (GABA) which reduces the symptoms of menopause in women. It has also high levels of essential amino acids leucine (10.7 g/100 g protein) and isoleucine (4.4 g/100 g protein) than wheat, rice and oats.

Most of the lipid content in pearl millet is present in germ around 21 per cent of the whole grain. The major fatty acids of pearlmillet grain are linoleic acid (39–45%); oleic acid (21–27%) and palmitic acid (20–21%). It is rich in unsaturated fatty acids (75%) with higher content of nutritionally important n-3 fatty acids than other cereal

grains. Pearl millet is rich in fat content (5 mg/100g) with better fat digestibility as compared to other grains.

It is a good source of vitamins and minerals. Approximate mineral content in *Bajra* is 2.3 mg/100g constituting iron, zinc, potassium, phosphorus, magnesium, copper and manganese. It is rich source of B-vitamins (thiamine, riboflavin and niacin). It is loaded with minerals with relative abundance of iron and zinc and higher vitamin A and folic acid.

Whole grain and bran are rich sources of phenolic compounds (phenolic acids and flavonoids) and a source of natural antioxidants. Pearl millet presents higher amounts (64.8 mg/kg) of phenolic acids with ferulic and p-coumaric acids being predominant. Phenolics are mainly found in the pericarp so the most beneficial form to consume pearl millet is as whole grain or bran which have immunosuppressive effects and can be used as dietary supplements for the treatment of autoimmune diseases.

Bajra has a high nutrient content but the nutrient bio-availability is low, due to the presence of anti-nutritional factors like phytic acid, polyphenol, C-glycosylflavones etc. High consumption of these compounds may lead to a reduction in the bio-availability of minerals, such as zinc, calcium and manganese, due to the chelating capacity of bivalent minerals. Protein and starch digestibility of pearl millet is low due to the presence of anti-nutrients in grains.

Health benefits of pearl millet: Pearl millet commonly known as *Bajra* in India has rich composition of minerals and proteins with many health benefitting properties.

– *Bajra* is rich in insoluble fibre (1.2g/100g) which helps in digestion and reduces constipation.

– The high amount of insoluble fibre lowers the risk of gallstone formation by reducing the production of bile juices in system.

– Pearl millet is also rich source of vitamins and minerals. It is a good source of essential amino acid, methionine; B-complex vitamins (niacin, thiamine and riboflavin); high iron, zinc, potassium and magnesium.

– The niacin content in *Bajra* is higher than all other cereals which reduces cholesterol thus, reducing the risk of cardiovascular diseases. Also magnesium is essential for maintaining good heart health, as it lowers blood pressure and reduces the risk of heart attacks..

– It is rich in iron and zinc with 8 times higher iron content than rice. With high iron (8mg/100g) and zinc content (3.1mg/100g), *Bajra* consumption can curb anaemia.

– It is very good for weight loss. Being high in fibre content, it takes longer time to move from the stomach to the intestines and in turn curbs hunger for a long span of time.

– *Bajra* has a good amount of lipids (5.6-7.1%) consisting both lecithins and cephalins, which are useful in brain function, behavioural disorders and stress. They help in regeneration of membranes and protect liver, lungs, kidneys and gastrointestinal tract. These compounds are known to enhance the bio-availability of other nutrients and medicines.

– Pearl millet is a good dietary option for diabetes patients to maintain the blood sugar level constant for a long period of time. *Bajra* with high amount of slowly digestible starch (SDS) and resistant starch (RS) contributes to low glycemic index (GI). This increases insulin sensitivities and reduces glucose level in blood. It digests slowly and releases glucose at a slower rate thus, maintaining healthy blood sugar levels for a long period of time.

– Pearl millet also contains significant amounts of potential antioxidants like phenols, phenolic acids and carotenoids. The protein has low prolamin fraction which makes it gluten free and it keeps its alkaline nature after cooking also, hence, ideal as food for gluten intolerance people.

– *Bajra* has anti-cancer properties due to phenolic compounds which inhibit tumor development. Its regular intake protects pre-menopausal women from developing breast cancer. Phenolic acids such as ferulic and p-coumaric, found in whole pearl millet have the capacity to reduce HT29 tumor cells. These phytochemicals also inhibit the action of pancreatic α-amylase and intestinal α-glycosidase enzymes that hydrolyze starch, oligosaccharides and disaccharides to monosaccharides reducing body hyperglycemia.

– *Bajra* is gluten free grain and beneficial in gluten intolerance or celiac disease. The celiac disease is triggered by the ingestion of gluten in genetically susceptible individuals. In the developed countries, there is a growing demand for gluten-free foods and beverages from people with celiac disease and other intolerances to wheat, barley, or rye. Since this grain is gluten-free, it has considerable potential in foods and beverages that can be suitable for individuals suffering from celiac disease.

– Pearl millet contains phytochemical called phytic acid which is believed to increase cholesterol metabolism. It also stabilizes the level of cholesterol in the body.

– *Bajra* is one of the very few foods that remains his alkaline property after cooking thus, prevent stomach ulcers caused by the excess acidity in the stomach.

Challenges in pearl millet utilization: In India, pearl

millet is a dual purpose crop as it provides cheap food for humans, feed for poultry birds and also dry as well as green fodder for cattle. Pearl millet grain is highly nutritious *viz*, 100 g of millet has the nutritional composition of energy 360 calories, carbohydrate 67g, protein 12g, fat 5g, moisture 12g, fibre 1g, mineral 2g, phosphorus 242mg, calcium 42mg and iron 8mg. Because of high nutritional value it has several health promoting abilities against diseases like diabetes, cancer, constipation, stomach ulcers *etc*. Despite being nutrient dense crop as compared to the major cultivated cereal crops pearl millet is an underutilized or neglected food grain in many countries. Major factors which limit its utilization are its poor shelf-life and the presence of anti-nutritional factors (phytate, tannins and polyphenols) which lowers the availability of minerals. Development of off odors and taste in the flour during storage of 10-17 days decreases market or economic value of the pearl millet. Because of the low shelf-life of flour, in rural area this becomes more laborious for the women as they grind the grain daily according to need. Low shelf-life of flour also limits the commercialization and utilization in urban culture. Although pearl millet is a nutrient rich crop, but its full potential is not exploited due to very short shelf-life of the flour. On storage of flour it produces off odour and turns rancid due to high amount of fat and high activity of lipase enzyme. Pearl millet flour high fat content, containing high polyunsaturated fatty acids (PUFA), makes it more susceptible to rancidity due to lipolysis and subsequent oxidation of PUFA. It contains around 74 per cent of total fats as unsaturated fatty acids like oleic (C18:1), linoleic (C18:2) and linolenic (C18:3). Unsaturated fatty acids undergoes oxidation in the presence of oxygen and moisture, resulting in development of undesired off odour named as oxidative rancidity. Few enzymes, which are essential in the metabolism of plants, remain active even after harvesting and lead to detrimental changes in quality attributes such as colour, flavour, texture and nutritional value of its products. The enzyme lipase is found in the pericarp and shows relatively higher activity in pearl millet as compared to other cereal grains. The lipase enzyme acts on the fat content stepwise and hydrolyses (hydrolytic rancidity) triacyl glycerol into diacyl glycerol, monoacylglycerol, glycerol and short chain free fatty acids. Lipoxygenase (LOX) of pearl millet catalyses oxidation reaction which produces medium chain aldehydes, ketones and their alcoholic counterparts, these lipid hydroperoxides decomposes and form secondary oxidation products, which can react with chlorophylls, carotenoids, ascorbic acid, phenols, a-tocopherol, etc. and cause alteration of colour and organoleptic properties pearl millet is also reported to contain oxidative enzyme such as peroxidase (POX) and enzymatic brownin, catalysed by enzyme such as polyphenol oxidase (PPO) which play important role in pearl millet flour quality deterioration.

Mitigation strategies for poor shelf-life: Various pre-processing and post-processing treatments have been developed to solve the problem of short shelf-life of pearl millet flour. It involves decorticating the grains, use of antioxidants, dry heat treatment to grain, acid treatment and hot water blanching, storage of pearl millet flour by refrigeration etc. Decortication is removal of outer surface of grains. This process helps to remove polyphenols and phytic acid, which enhances the acceptability of pearl millet flour and its product. By adding antioxidants, namely butylated hydroxyanisole (BHA-0.02%), butylated hydroxytoluene (BHT-0.02%) and ascorbic acid (0.5%) just after grinding pearl millet can enhance the shelf-life of flour. Dark gray colour of pearl millet grains limits their use in food preparation. This problem can be overcome by treating decorticated seeds with various organic acids (such as acetic, fumaric, tartaric acid) or sometimes with natural acidic materials such as tamarind. One of the most effective techniques for enhancing the shelf-life of pearl millet flour is blanching, which slows down the enzymatic activity without having any significant effect on its nutritional composition. It is done by immersing of the grains in the boiling water for 30 seconds and drying at 50°C for 60 minutes. Dry heating for 120 minutes revealed significant reductions in fat acidity, acid value, free fatty acid profile during 30 days of storage period. Dry heat treatment of pearl millet grains before milling resulted in better keeping quality and acceptability of flour. Refrigeration greatly improved the acceptability of flour before and after cooking. Besides processing techniques, development of pearl millet varieties and hybrids (through conventional plant breeding) with improved inherent capacity of pearl millet with longer shelf-life is an alternative approach. However, there is not enough work in the development of varieties and hybrids with increased shelf-life. Therefore, to strengthen this area, identification of determinant of rancidity might be its solution. Work is going on to determine variability in rancidity profile (using parameters: peroxide value and acid value) and rancidity indicators or determinants (fat content, total phenol content, development of FA and activities of POX, LOX and PPO) in pearl millet germplasm.

Received : *31.08.2020* ***Revised :*** *12.11.2020* ***Accepted :*** *19.11.2020*