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Review Article

WONDER MILLET – PEARL MILLET, NUTRIENT COMPOSITION AND POTENTIAL HEALTH BENEFITS - A REVIEW

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ABSTRACT
Pearl Millet is highly valuable in semi arid regions because of higher productivity under heat and drought conditions. Pearl millet are nutritionally comparable and even superior to major cereals with respect to protein, energy, vitamins, and minerals. Dieticians and many health professionals recommended Pearl millet because of its various health benefits and good effect on the body.

Keywords: *Pearl Millet, Productivity, Drought, Health Benefits*

INTRODUCTION
Pearl millet (*Pennisetum glaucum*), also known as Bajra, is one of the four most important cereals (rice, maize, sorghum and millets) grown in marginal agricultural areas where annual rainfall is variable, unpredictable and very low (200–500 mm) and where daily temperature reaches 30°C (FAO, 2012). Pearl millet is a nutritious cereal grown on about 10 million hectares in India, as well as India is one of the largest producers of pearl millet crop in the world. Besides providing food for human, millet stems are used for a wide range of purposes, including: the construction of hut walls, fences and thatches, and the production of brooms, mats, baskets, sunshades, etc (IFAD, 1999).

English Name: *Pearl Millet*
Scientific Name: *Pennisetum glaucum*
Names in Other Languages: Grano (Spanish)**,** Type de graine (French)**,** Bajra (Hindi), Kamboo (Tamil & Malayalam), Sajjalu (Telugu), Bajri (Marathi, Gujarati), Bajra (Bengali, Oriya, Punjabi & Urdu)

Nutritive Value of Pearl Millet:
Nutritional quality of food is a key element in maintaining human overall physical well-being because nutritional well-being is a sustainable force for health and development and maximization of human genetic potential. Therefore, for solving the problem of deep-rooted food insecurity and malnutrition, dietary quality should be taken into consideration (Singh and Raghuvanshi, 2012).
In developing countries, pearl millet is recognized as an important crop, which helps with food shortages and meeting the nutritional demands of an increasing population. It constitutes an important source of dietary calories and protein in the daily diet of a large segment of the poor population (Simwemba *et al.,* 1984).
Pearl millet was found significantly rich in resistant starch, soluble and insoluble dietary fibers, minerals, and antioxidants (Ragaee *et al.,* 2006). It contains about 92.5% dry matter, 2.1% ash, 2.8% crude fiber, 7.8% crude fat, 13.6% crude protein, and 63.2% starch (Ali *et al.,* 2003).

Energy:
Pearl millet is a rich source of energy (361 Kcal/100g) which is comparable with commonly consumed cereals such as wheat (346 Kcal/100g), rice (345Kcal/100g) maize (125 Kcal/100g) and sorghum (349Kcal/100g) as per the Nutritive value of Indian foods (NIN, 2003).

Carbohydrate:
Carbohydrate components of pearl millet grains comprise of starch, dietary fiber and soluble sugars. Pearl millet starches have amylose content ranging 20-21.5% and have a higher swelling power and solubility than other starches (Lestieme *et al.,* 2007). In different pearl millet verities the starch content of the grain varies from 62.8 to 70.5 %, soluble sugar from 1.2 to 2.6 %. Free sugars like glucose, fructose, sucrose and raffinose are present in a range of 1.2 to 2.5% (Jambunathan and Subramanian, 1987; Gupta and Nagar, 2010).

Table 1: Proximate Composition (g/100g) of Pearl Millet Grains

Moisture (g)	Protein (g)	Fat(g)	Ash(g)	Fiber(g)	References
-	10.6	-	-	-	(Andrews, 1990)
-	10.5-11.1	4.0-6.3	1.5-1.8	0.8-1.2	(Saxena *et al.*, 1992)
-	10.4	6.0	1.6	-	(Aggarwal, 1992)
-	-	-	-	1.5	(Navita and Sumathi, 1992)
-	9.4	6.5	2.0	-	(Kumar and Chauhan, 1993)
10.7	15.4	5.2	1.7	-	(Almeida Dominguez *et al.*, 1993)
-	12.7	4.3	1.5	-	(Hadimani and Malleshi, 1993)
10.3	17.9	6.7	1.8	-	(Serna Saldivar *et al.*, 1994)
-	-	6.1-7.5	-	-	(Dalvi, 1995)
-	8.1-13.9	3.4-7.4	1.1-2.4	-	(Hadimani *et al.*, 1995)
-	12.3	5.3	2.4	-	(Bashay, 1996)
7.4-8.4	8.7-10.8	6.4	-	-	(Elkhalifa and Singh, 1996)
11.30-11.49	11.3-13.2	7.2-7.8	1.9-2.1	1.99	(Kumari, 1997)
11.26-11.37	12.8-13.1	6.2-7.4	1.9-2.1	1.95	(Sehgal and Rekha, 1997)
-	8.5	7.1	2.4	2.6	(Abdalla *et al.*, 1998)
-	16.9	5.1	1.5	1.6	(Malleshi and Klopfenstein, 1998)
-	-	6.2	-	-	(Banger *et al.*, 1999)
-	11.4	-	-	-	(Oshodi *et al.*, 1999)
7.13	12.2	4.5	0.25	0.54	(Akubor and Obiegbuna, 1999)
9.26	10.9	5.8	1.4	0.8	(Malik, 1999)
8.78	10.36	7.63	2.03	1.26	(Sehgal *et al.*, 2003)

Proteins:

Pearl millet grain is gluten-free. Pearl millet contains generally 9 to 13% protein. The essential amino acid profile shows more lysine, threonine, methionine and cystine in pearl millet protein than in proteins of sorghum and maize (Adeola *et al.*, 2005). Its tryptophan content is also higher (Ejeta *et al.*, 1987; Hoseney *et al.*, 1994; Rooney *et al.*, 1987).

The lysine content of the protein reported in pearl millet grain ranges from 1.9 to 3.9 g per 100 g protein (SernaSaldivar, McDonough and Rooney, 1994). This favorable amino acid balance with a high level of essential amino acids, coupled with the superior in vitro pepsin digestibility values, suggests that pearl millet is a nutritious and well-digested source of calories and protein for humans (Ejeta *et al.*, 1987). Among the essential amino acids, ariginine, threonine, valine, isoleucine and lysine had higher digestibility in pearl millet. Pearl millet exhibits higher apparent small intestine digestibility of essential amino acids than other grains (Adeola *et al.*, 2005; Kalinova and Moudry, 2006).

Lipids:

The overall lipid content in pearl millet grain ranges from 1.5 to 6.8% which is higher than all the millets (Taylor, 2004). The fatty acid in pearl millet is higher in palmitic, stearic and linolenic acids and lower in oleic and linoleic acids (Adeola *et al.*, 2005). The energy density of pearl millet grain is relatively high, arising from its higher oil content (Hanna *et al.*, 1990). About 75% of the fatty acids in pearl millet are unsaturated and linoleic acid is particularly high (46.3%).

Micronutrients:
Minerals:
The environmental factors like composition and nature of soil can determine the mineral content of grain. Pearl millet is a good source of minerals, containing appreciable amounts of calcium, phosphorus, magnesium, and iron (Burton *et al.,* 1992). The ash content of pearl millet ranged from 1.6 to 3.6% (Serna *et al.,* 1994).
Pearl Millet is a important source of minerals, which are found in the pericarp, aleurone layer and germ, Refining remove of these parts of the millet, result in the loss of some of these important nutrients (Serna-Saldivar and Rooney, 1994; Shahidi and Naczk, 2003).

Table 2: Mineral Composition mg/100g of Pearl Milet

Phosphorus	Calcium	Iron	Znic	Copper	Manganese	Phytic Acid	References
185.0-363.0	13.0-52.0	4.0-5.83	1.0-6.6	0.6-1.22	1.8	_	(Jambunathan 1989)
302	51.4	16.3	1.21	1.21	1.53	_	(Kumar, 1989)
-	50.0	18.0	-	-	-	_	(Khatarpaul and Chauhan, 1991)
290	54.8	11.8	-	-	-	354 -857	(Aggarwal, 1997)
272-326	27.46	-	-	-	-	_	(Saxena *et al.*, 1992)
-	51.4	16.3	-	-	-	825.7	(Kumar and Chauhan, 1993)
300.5	-	3.00	-	-	-	_	(Hadimani and Malleshi, 1994)
355	79.0	8.9-9.7	-	-	-	_	(Serna Saldiwar *et al.*, 1994)
349.0-376.7	45.7-50.0	8.9-9.4	2.7-2.9	1.11-1.23	1.20	737.8	(Kumari, 1997)
364-385.6	44.5-49.7	7.0-18.0	2.7-2.8	1.16-1.23	1.23	354-857	(Sehgal *et al.*, 2003)
450-990	10.0-60.0	8.3-9.9	5.3-7.0	1.8	2.3	354- 796	(Rathi *et al.*, 2004)
-	19.9-22.5	8.16	3.2	1.0	-	_	(Malik, 1999)

Vitamins:
Pearl millet grain is an important source of thiamine, niacin and riboflavin (Taylor, 2004). Pearl millet grains contain 0.38mg of thiamine, 0.21 mg riboflavin, 2.8 mg of niacin (Hulse *et al.*, 1980).
Due to its high oil content, pearl millet is also a good source of lipid-soluble vitamin E. Its content in pearl millet is about 23 mg/100 g (Taylor, 2004). Its presence could be of importance to pearl millet as an antioxidant that may curb triglyceride deterioration. Pearl millet is also a good source of the lipid-soluble vitamin A. These vitamins are mainly located in the germ.

Potential Health Benefits in Pearl Millet

Epidemiological evidence from research studies has shown that diets rich in plant foods are protective against several degenerative diseases such as cancer, cardiovascular ailments, diabetes, metabolic syndrome, and Parkinson's disease (Manach *et al.*, 2005; Scalbert *et al.*, 2005; Chandrasekara and Shahidi, 2012).
Millets must also be accepted as functional food and nutraceuticals because they provide dietary fibers, proteins, energy, minerals, vitamins, and antioxidants required for human health. Several potential health benefits such as preventing cancer and cardiovascular diseases, reducing tumor incidence, lowering blood pressure, risk of heart disease, cholesterol, and rate of fat absorption, delaying gastric emptying, and supplying gastrointestinal bulk were reported for millets (Truswell, 2002; Gupta *et al.*, 2012).

Disease	Health Benefits in Pearl Millet
Anaemia	High iron content (8mg/100g) High Zinc content (3.1mg/100g) May help in increasing Hb (Sehgal *et al.*, 2003)
Constipation	High fiber (1.2g/100g) content, May help in dealing with constipation.
Diabetes	The intake of whole grain foods is suggested to be beneficial for the prevention and management of diabetes mellitus, and epidemiologically lower incidence of diabetes has been reported in millet-consuming populations (American Diabetes Association, 2005). Has Low glycemic index, Help in dealing with diabetes. Starch fractions such as SDS and/or RS are nutritionally important as they have significant implications on human health, particularly glucose metabolism, diabetes management, (Shobana *et al.*, 2009; Kim *et al.*, 2011).
Cancer	Anti cancer property Inhibit tumour Development. Rich in phenolic acids, tannins, and phytate that act as "anti nutrients" (Thompson, 1993). However, it has been established that these antinutrients reduce the risk for colon and breast cancer in animals (Graf and Eaton, 1990)
Celiac	Pearl millets are gluten-free, they have considerable potential in foods and beverages that can be suitable for individuals suffering from celiac disease (Taylor *et al.*, 2006; Taylor and Emmambux, 2008).
Diarrhea	Due to presence of Lactic acid bacteria act as Probiotic treatment.
NCDs	Peral millet have Flavonoids, phenolics Omega 3 fatty acids, Inhibits DNA scission, LDL cholesterol, liposome oxidation and proliferation of HT-29 adenocarcinoma Cells. So help full in NCD (Chandrasekara and Shahidi, 2011).
Helps in bone growth development and repair	Pearl millet has a large amount of phosphorus and also a good source of calcium. Both are very essential for bone growth and development.
Stomach Ulcers	The most common cause for stomach ulcers is excess acidity in the stomach after food intake. Pearl millet is one of the very few foods that remains his alkaline property thus prevents formation of stomach ulcers or reduces the effect of ulcers.

Heart health	The lignin and phytonutrients in millet act as strong antioxidants thus preventing heart related diseases. So that pearl millet is considered good for heart health (Ahmed *et al.,* 2009). High amounts of magnesium present in pearl millet have been shown to control blood pressure and relieve heart stress.
Respiratory problems for asthma patients	Pearl millet contains high concentration of magnesium which helps reduce severity of respiratory problems for asthma patients and is also effective in reducing migraine attacks
Weight loss (Obesity)	Pearl millet can be beneficial in the process of weight loss as it is high in fibre content (Scalbert *et al.,* 2005).
Preventing Gall stones:	The high fibre content in pearl millet is also known to reduce the risk of gall stone occurrence. The insoluble fibre content in pearl millet reduces the production of excessive bile in our system (Liu, 2007).
High Satiety value	Owing to its fibre content it takes longer for the grain to move from the stomach to the intestines (Miller, 2001). This way, pearl millet satiates hunger for a long period of time and thus helps in lowering the overall consumption of food.
Well digested source of nutrients	Pearl millet exhibits higher apparent small intestine digestibility of essential amino acids than other grains. With a high level of essential amino acids coupled with superior in vitro pepsin digestibility values, suggests that pearl millet is a nutritious and well-digested source of calories and protein for humans.
Anti allergic Properties	Pearl millet is a treasure trove of beneficial properties. The grain is very digestible as such and has a very low probability of causing allergic reactions. Due to its hypo allergic property, it can be safely included in the diets of infants, lactating mothers, elderly and Convalescents
Anti ageing	The chemical reaction between the aldehyde group of reducing sugars and the amino group of proteins, termed as non enzymatic glycosylation, is a major factor responsible for the complications of diabetes and aging (Monnier, 1990). 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).

Conclusion

Pearl millet is the nutritious but underutilized grain crop used as traditional food preparation by the people of lower economic strata. It is called as" pearl millet". It is not expensive like pearl but it's definitely has pearl like quality which is beneficial to the body. 100 grams of bajra has the following nutritional values: energy 360 calories, moisture 12g, protein 12g, fat 5g, mineral 2g, fiber 1 g, carbohydrate 67g, Calcium 42mg, phosphorus 242mg, and iron 8mg. Therefore, with value-added strategies and appropriate processing technologies, the millet grains can find a place in the preparation of several value-added and health food-products, which may then result in high demand from large urban populations and non-traditional millet users (Mal *et al.,* 2010). Dieticians and Nutritionist are trying their best to educating about potential health benefits among all groups of people and promote this particular millet by increase its consumption. Awareness among the people helps to create a positive attitude towards this millet.

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