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Application of pearl millet in functional food

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Abstract : Pearl millet (*Pennisetum glaucum*) is locally known as bajra. It is drought resistant crop and gives good productivity in areas with low rainfall, low soil fertility and high temperature where other cereal crops, such as wheat, rice and maize are not grown properly. Pearl millet is the staple food for economically poorer section of the world's population, due to all these characteristics of pearl millet it is considered as a poor man's cereals. Pearl millet is rich source of phytochemicals and micronutrients play important role in our immune system. Also pearl millet has antioxidant properties which help to reduce blood pressure, risk of heart disease, diabetes, prevention of cancer, cardiovascular diseases, etc. Other health benefits is high fibre which helps to dealing with constipation, high amount of iron and zinc specially biofortified varieties which help to overcome the problem of mineral deficiency. Pearl millet is gluten free and after being cooked it is the only grain which retains its alkaline properties. All these characteristics of pearl millet makes it good source of functional food. Aim of this paper is reviews the application of pearl millet in functional food.

Key words : Pearl millet, Cereal, Functional food, Mineral, Biofortified, Deficiency

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Today's busy lifestyle and diet are major factors which influence susceptibility to many diseases. Drug addiction, tobacco smoking, alcohol drinking as well as too much or lack of exercise may also increases the risk of developing diseases. Also due to poverty and low income status, most communities in developing countries largely consume cereal and inadequate nutritional foods leads to this malnutrition and/ or deficiency. Inadequate consumption of macronutrients like carbohydrate, protein and fat leads to under nutrition with a consequent feeling of hunger. Unlike macronutrients mentioned above micronutrients required in trace amount but they play vital role in various physiological functions and their deficiencies do not leads to hunger effects. Thus these micronutrients deficiencies are also called hidden hunger. Iron and zinc are two of the most critical micronutrients deficient in developing countries, particularly in rural area or in the low- and middle-income countries (UNICEF, 2015). In India alone about 80% of the pregnant women, 52% of non- pregnant women and 74% of children in the 6-35 months age group suffer from iron deficiency and about 52% of children below 5 years are zinc deficient (Murray-Kolb and Beard, 2009). Micronutrient deficiencies commonly affect about two billion people mostly in developing countries (FAO, 2013). At this condition especially during the situations of climate changes, water scarcity, increasing world population and rising food prices scientist and nutritionist have challenge to produce, processing and utilizing other potential food sources to fight against these malnutrition and deficiency diseases.

Pearl millet :

Pearl millet (*Pennisetum glaucum*) is most widely grown type of millet and account for approximately 50% of the world millet production (ICRISAT, 2016). Pearl millet ranks first under the category of millet in India in terms of area, production and productivity. In India the state of Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana roughly account for more than 90% of total area under pearl millet. Because of its tolerance to difficult growing conditions such as drought, low soil fertility and high temperature, it can be grown in areas where other cereal crops, such as maize, wheat would not survive (Devi *et al.,* 2011). Pearl millet contains about 92.5% dry matter, 2.1% ash, 2.8% crude fibre, 7.8% crude fat, 13.6% crude protein and 63.2% starch (Ali *et al.,* 2003). It has the crucial source of iron and zinc specially biofortified variety also it has significantly rich in resistant starch, soluble and insoluble dietary fibres, minerals and antioxidants (Ragaee *et al.,* 2006).

Area,production and productivity of pearl millet at all India level in year 1970 to 2015 are given below in Table 1. In 1970-71, the area under pearl millet was 12.91 million hector and it declining steadily over the next four decades to reach 7.31 million hector in 2014-15. Production of pearl millet has decreased 0.69 million tonne in the decade 1970-71 and 1980-81 and increased small of 1.15 million tonne in year 1990-91 to 2000-2001. But increased production of 6.6% during the year 2010-11 to 2014-15. However productivity is dropped only in the first decade in 1970-71 to 1980-81 and recovered in the next two decades (GOI, 2016).

Additional health benefits of pearl millet :

Apart from economically feasible and high nutritious diet, pearl millet also comprises other essential health benefits. Its outstanding composition makes it an effective food for the treatment of cancers, anaemia, constipation, diabetes, allergies and non-communicable diseases. From all these several nutrients content in pearl millet it accepted as functional and nutraceutical food (Table 2) (Saleh *et al*., 2013).

Biofortificaion :

Biofortificaion is the process by which the bioavailability of important target minerals is increased by concentrating them in the edible parts of plants through agronomic methods and genetic selection (White and Broadley, 2005). Biofortificaion is believed to be a cost effective and sustainable way to fight micronutrient malnutrition in poor communities (Taylor *et al*., 2014). Due to continuous consuming biofortified crops measurable improvement occurred in human health and nutrition (Bouis *et al*., 2011). Pearl millet is largely being consumed in many states in India including Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana. So there is an opportunity to increase the intake of

Table 1 : Area, production and yield of pearl millet in India (1970-2015)

Period	Area (mha)	Production (mt)	Productivity (kg/ha)
1970-71	12.91	8.03	622
1980-81	11.66	5.34	458
1990-91	10.48	6.89	658
2000-01	9.83	6.76	688
2010-11	8.68	8.61	991
2014-15	7.31	9.18	1255

Source- Department of agriculture and cooperation, GOI, 2016

Table 2: Additional health benefits of pearl millet

Sr. No.	Health disorder	Potential benefits	Positive properties in pearl millet
1.	Anaemia	Enhancing the level of Hb	High iron and zinc content
2.	Constipation	Enhancing the problem of constipation	High fibre
3.	Cancer	Anti-carcinogenic property, Reduce the risk of tumour development	Antioxidant property
4.	Celiac	Anti-allergic	Gluten free
5.	Diabetes	Anti-diabetic	Low glycemic index
6.	Diarrhoea	Act as probiotic	Lactobacillus

micronutrients by breeding high mineral dense cultivars (process so called biofortification).

The Fe deficiency causes lowering work capacity, lowered immunity to infections, and pregnancy complications (e.g., babies with low birth weight and poor learning capacity). Iron deficiency also induced severe anaemia is a direct cause of maternal and child mortality (Draper, 1996). Zinc deficiency in children makes them vulnerable to diarrhoea, pneumonia, mortality and causes stunting. To overcome these micronutrient deficiency studies at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, conducted in jointly work with the harvestplus biofortification programme of the consultative group on International Agricultural Research, and in partnerships with several public and private sector pearl millet research programs, have released and commercial cultivars, both for iron and zinc content variety. Both openpollinated and hybrid varieties released jointly by ICRISAT and All India Coordinated Pearl Millet Improvement Project, showed iron content varying from 42 to 80 mg/kg in varieties and from 31 to 61 mg/kg in hybrids. The zinc content varied from 37 to 52 mg/kg in varieties and from 32 to 52 mg/kg in hybrids. Not all hybrid and open pollinated varieties holding the unique level of minerals of this crop (ICRISAT, 2016).

Some iron and zinc biofortifiedvarietiesof pearl millet and their releasing year are summarised in following Table 3.

Table 3: Biofortified varieties and their releasing year

Sr. No.	Varieties	Releasing year
1.	Dhanashakti	2012
2.	ICMH 1201	2014
3.	ICMH 1301	2014
4.	AHB 1200 Fe	2016

Functional food :

The term functional food was first introduced in japan in the mid-1980 and refers to processed foods containing ingredients that aid specific bodily functions in addition to being nutritious. Functional food can be defined as food which provides additional physiological benefit beyond that of meeting basic nutritional needs. A food can be made functional by applying any technical method to enhance the concentration of, add, remove or modify a particular component as well as to improve its bioavailability, provided that component has been demonstrated to have functional effect (Roberfroid, 1999). Functional food includes a wide range of foods and food component that helps to improve overall health and reduce the risk of specific disease. These food include, for example, lycopene in tomatoes, isoflavones in soya, omega-3 fatty acids in fish, β-glucan in oats, calcium in milk, naturally healthful component in fruits, etc.

Pearl millet is drought resistant and short growing season crop as compared to other major cereal. Because of containing dietary fibre, carbohydrate, protein, minerals, vitamin and antioxidants in cereal require for human health are accepted as functional and nutraceutical food (Charalampopoulos *et al.*, 2002). Researchers and nutritionist give more attention for processing and preparation of various functional foods from them. Also its availability and low cost is affordable to poor man. So, use of pearl millet for preparing various types of functional food is beneficial.Following various technologies are used in food processing for improving nutritional quality and bioavailability in pearl millet. Also by following ways product from pearl millet make it functional or nutraceutical.

Bakery product :

Bakery products are popular both in urban and rural area because of their sensory qualities, convenience, ready to eat nature and long shelf life. Bakery product is frequently purchased and daily consumed products. As a consequence they may be a good carrier for bioactive substances hence bakery product helps to increase the intake of specific nutrients. Refined wheat flour is the base ingredients in bakery products. Refined wheat flour is a product of refining that contains higher proportion of starch low dietary fibre and minerals and the result cookies are characterised with low proteins, fat and mineral content (Archna *et al.*, 2004). Because of low fibre content interest in research has arisen in increasing fibre content in diet. Also studied proved that baked products have to be acceptable carrier of fibre from various sources (Brockmole and Zabika, 1976). Therefore to improve its nutritive value there is need to substitution wholly or partially with flours rich in nutrients and/or nutraceutical components which are inexpensive and easily available to enhance the quality of cookies.

Fermented products :

Fermentation is one of the effective method for reducing polyphenols and phytic acid significantly with improving availability of minerals (Sripriya *et al.*, 1996; Murali and Kapoor, 2003). There are various recipes were prepared from naturally and mixed fermented pearl millet flour including cutlets, weaning food and vermicelli which were highly acceptable. Fermentation of pearl millet of 9 hrs decreases the phytic acid from 27-30% and polyphenols from 10-12% (Dhankher and Chauhan, 1987).

Germinated product :

Malting of pearl millet reduces protein content, but improves protein efficiency ratio (PER), lowering antinutritional factor and increase availability of minerals (Desai *et al.*, 2010;Krishnan *et al.*, 2012). Three days malting of pearl millet resulted in reduction of phytate 19-33% (Onyango *et al.*, 2013). Various traditional as well as modern food products are made from germinated pearl millet flour as a functional food.

Conclusion :

Pearl millet contains many health promoting components such as dietary fibre, minerals, vitamin and phytochemicals and comparable to major cereals they also have drought resistant crop. Production of functional food by fortification of pearl millet is an effective method that can be used to overcome nutrient deficiencies. However encouraging production and processing with minimum cost are required to enhance the intake of pearl millet.

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■ REFERENCES

Ali, M.A.M., El Tinay, A.H. and Abdalla, A.H. (2003). Effect of fermentation on the invitro protein digestibility of pearl millet. *Food Chem.*, **80**(1) : 51-54.

Archna, R., Asna, K., Salil, S. and Byron, H. (2004). Influence of depigmentation of pearl millet (*Pennisetum glucum*) on sensory attributes, nutrient composition and *in vitro* digestion of biscuits. *Food Sci. & Technol.*, **37** : 184-192.

Bouis, H.E., Hotz, C., McClafferty, B., Meenakshi, J.V. and Pfeiffer, W.H. (2011). Biofortification : a new tool to reduce micronutrient malnutrition. *Food & Nutri. Bull.*, **32** : 31-40.

Brockmole, C.L. and Zabik, M.E. (1976). Fibre component quantisation and relationship to cake quality. *J. Food Sci.*, **44**: 1732.

Charalampopoulos, D., Wang, R., Pandiella, S.S. and Webb, C. (2002). Application of cereal and cereal components in functional food: a review. *Internat. J. Food Microbiol.*, **79**: 131-141.

Desai, A.D., Kulkarni, S.S., Sahu, A.K., Ranveer, R.C. and Dandge, P.B. (2010). Effect of supplementation of malted ragi flour on the nutritional and sensorial quality characteristics of cake. *Adv. J. Food Sci. Technol.*, **2**(1):67-71.

Devi, P.B., Vijayabharathi, R., Sathyabama, S., Malleshi, N.G. and Priyadarisini, V.B. (2011). Health benefits of finger millet (*Eleusine coracana* L.) polyphenols and dietary fiber: a review. *J. Food Sci. & Technol.*, DOI: 10.1007/s13197-011-0584-9.

Dhankher, N. and Chuhan, B.M. (1987). Effect of temperature and fermentation on phytic acid and polyphenol content of rabadi- a fermented pearl millet food. *J. Food Sci.*, **52** : 828-9.

Draper, A. (1996). Child development and iron deficiency, the oxford brief.

FAO (2013). The state of food insecurity in the world : food systems for better nutrition. Food and Agriculture Organization.

ICRISAT (2016). Pearl millet. International Crops Research Institute for the Semi-Arid Tropics.

Government of India (GOI). (2016). Agricultural statistics at a glance, Ministry of Agriculture and Farmer Welfare, New Delhi.

Krishnan, R., Dharmaraj, U. and Malleshi, N.G. (2012). Influence of decortication, popping and malting on bioaccessibility of calcium, iron and zinc in finger millet. *LWT-Food Sci. & Technol.*, **48**(2): 169-174.

Murali, A. and Kapoor, R. (2003). Effect of natural and pure culture fermentation of finger millet on zinc availability as predicted from HCL- extractability and molar ratios. *J. Food Sci. & Technol.*, **40**(1): 112-114.

Murrary-Kolb, L.E. and Beard, J.L. (2009). Iron deficiency and child and maternal health. *American J. Clinical Nutri.*, **89** : 946-950.

Onyango, C.A., Ochanda, S.O., Mwasaru, M.A., Ochieng, J.K., Mathooko, F.M. and Kinyuru, J.N. (2013). Effect of malting and fermentation on anti-nutrient reduction and protein digestibility of red sorghum, white sorghum and pearl millet. *J. Food Res.*, **2**(1): 41-49.

Ragaee, S., Abdel-Aal, E.M. and Noaman, M. (2006). Antioxidant activity and nutrient composition of selected cereals for food use. *Food Chem.*, **98**(1): 32-8.

Roberfroid, M.B. (1999). What is beneficial for health? The concept of functional food. *Food Chem. Toxicol.,***37**: 1039-1041.

Saleh, A.S.M., Zhang, Q., Chen, J. and Shen, Q. (2013). Millet grains: Nutritional quality, processing, and potential health benefits. *Comprehensive Rev. Food Sci. & Food Safety*, **12** : 281-295.

Sripriya, G., Usha, Antony and Chandra, T.S. (1996). Changes in carbohydrate, free amino acids, organic acids, phytate and HCL extractability of minerals during germination and fermentation of finger millet. *Food Chem.*, **58**(4): 345-350.

Taylor, J.R.N., Belton, P.S., Beta, T. and Duodu, K.G. (2014). Increasing and utilisation of sorghum, millets and pseudocereals: Developments in the science of their phenolic phytochemicals, biofortification and protein functionality. *J. Cereal Sci.*, **59** : 257.275.

UNICEF (2015). Micronutrients. United Nations Internations International Children's Emergency Fund. Available from : http.//www.unicef.org/nutrition/index_iodine.html (assessed 07 November, 2016).

White, P.J. and Broadley, M.R. (2005). Biofortifying crops with essential mineral elements. *Trends Plant Sci.*, **10** : 586-393.