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THERAPEUTIC VALUE OF PEARL MILLET & UTILIZATION IN DEVELOPMENT OF GLUTEN FREE FOOD PRODUCTS

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ABSTRACT

Pearl millet is a highly nourishing food, it is nutritionally comparable and even superior to other major cereals with respect to energy, protein, vitamins and minerals still its consumption is restricted to lower income sections of the society. Along with good nutritive value pearl millet possesses several health benefits as well which include preventing diabetes mellitus, cancer, cardiovascular diseases, reducing tumor incidence, lowering blood pressure, risk of heart disease, cholesterol and rate of fat absorption. In the present study nutritive value of pearl millet and its health benefits for people suffering from celiac disease, diabetes mellitus, cardiovascular diseases and its role against cancers has been discussed. Pearl millet and rice based multi grain gluten free *chapati* has been developed in the present study, results of organoleptic analysis indicated that *chapati* was liked moderately by the panelists. Development of multi grain gluten free *chapati* has led to diversification in utilization of pearl millet along with providing safe, nutritious and low cost food product. The intake of whole grain and multi grain foods is suggested to be beneficial for the prevention and management of numerous diseases and is creating more opportunities for utilization of tremendous therapeutic potential of pearl millet.

INTRODUCTION

Pearl millet is one of the most important drought-resistant crops and it has resistance to pests and diseases, short growing season, and productivity under drought conditions, compared to major cereals (Devi *et al.,* 2011). The world total production of millet grains at last count was 762712 metric tons and the top producer was India with an annual production of 334500 tons (43.85%) (FAO, 2012). In many African and Asian areas, pearl millet serves as a major food component, is used in various traditional foods and beverages specifically among the non affluent segments of societies (Chandrasekara *et al.,* 2012). In addition to their nutritive value, several potential health benefits such as delaying gastric emptying, supplying gastrointestinal bulk preventing cancer, cardiovascular diseases, reducing tumor incidence, lowering blood pressure, risk of heart disease, cholesterol and rate of fat absorption have been reported for pearl millet (Gupta and Nagar, 2010). Pearl millet is reported to be a highly nourishing food and a richer source of protein, calcium, and iron than some of the other important cereals (Hadimani *et al*, 1995). Pearl millet was found significantly rich in resistant, starch, soluble and insoluble dietary fibers, minerals, and antioxidants (Ragaee *et al.,* 2006). Phenolic compounds from pearl millet grains showed potential anti diabetic effects (Truswell 2002). Therefore, pearl millet grains can be used in preparing various food products for diabetics.

There is strong epidemiological evidence that whole-grain cereals protect the body against age-related diseases such as diabetes, cardiovascular diseases, and some cancers (Fardet *et al.,* 2008). Though pearl millet contributes potentially towards national food security, pearl millet as a food resource has been relatively neglected but it is now receiving increasing attention from agriculture and food security policymakers (Saleh *et al.,* 2013). The presence of all the required nutrients in pearl millet makes it suitable for large-scale utilization in the manufacture of food products such as health foods, gluten free foods, dietary foods, baby foods, snack foods, and others (Liu *et al.,* 2012). With value-added strategies and nutritional awareness pearl millet can find a place in the preparation of several value-added and health food products for celiac disease sufferers, diabetics, cardiovascular disease patients which may then result in high demand from large urban populations and nontraditional pearl millet users (Mal *et al.,* 2010).

Nutritive Value of Pearl Millet

Nutritional quality of food is a key element in maintaining human overall physical well-being because nutritional well-

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being is a sustainable force for health and development and maximization of human genetic potential. Therefore, for solving the problem of deep-rooted celiac disease, cardiovascular diseases, diabetes mellitus, food insecurity and malnutrition, dietary quality should be taken into consideration (Singh and Raghuvanshi, 2012). In addition to cultivating advantages, pearl millet was found to have high nutritive value and comparable to that of major cereals such as wheat and rice (Parameswaran and Sadasivam 1994). Pearl millet has high amount of balanced protein and lipids (L. Labetoulle, 2000). It has also been reported that pearl millet proteins are good sources of essential amino acids except lysine and threonine but are relatively high in methionine. Pearl millet is also rich sources of phytochemicals and micronutrients (Singh *et al.,* 2012).

Pearl Millet for diabetics

Diabetes mellitus is considered as the most common endocrine disorder and results in deficient insulin production (type 1) or combined resistance to insulin action and the insulin secretory response (type 2). Diabetes mellitus is a chronic metabolic disorder characterized by hyperglycemia with alterations in carbohydrate, protein, and lipid metabolism. It is considered as the most common endocrine disorder and results in deficient insulin production (Type 1) or combined resistance to insulin action and the insulin-secretory response (Type 2). However, although chemical synthetic inhibitors of alpha-glucosidase and pancreatic amylase play a vital role in the clinical management of postprandial hyperglycemia, natural inhibitors are potentially safer. 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 (Kim *et al.,* 2011). It has also been documented that all the products made with the inclusion of pseudo cereals (pearl millet, amaranth and buckwheat) showed a significant reduction in readily digestible carbohydrates and slowly digestible carbohydrates compared to the control product during predictive *in vitro* glycemic profiling (Brennan *et al.,* 2012).

Some *in vivo* studies were carried out in order to investigate the effect of pearl millet grains on diabetes. In one study, the influence of six Sudanese traditional carbohydrate-rich meals on glucose and insulin responses in diabetic subjects was measured. The results showed that pearl millet acida (porridge) followed by wheat gorasa (pancakes) displayed significantly lower postprandial glucose and insulin responses, whereas maize acida induced a higher postprandial glucose and insulin response (Abdelgadir *et al.,* 2004). In another study, the levels of enzymatic (glutathione and vitamins E and C) and nonenzymatic antioxidants (superoxide dismutase, catalase, glutathione peroxidase, and glutathione reductase) and lipid peroxides were significantly reduced in diabetic animals and restored to normal levels in the pearl millet-fed groups (Hegde *et al.,* 2005). It has also been documented that pearl millet helps to control blood glucose levels in diabetic patients very efficiently (Desai *et al.,* 2010).

Pearl Millet and cardiovascular disease

Obesity, smoking, unhealthy diet, and physical inactivity increase the risk of heart attacks and strokes. Most of the world countries face high and increasing rates of cardiovascular disease. It has been demonstrated that rats fed with a diet of native and treated starch from pearl millet had the lowest blood glucose, serum cholesterol, and triglycerides compared with rice and other minor millets (Kumari and Thayumanavan, 1997). Pearl millet prevented cardiovascular disease by reducing plasma triglycerides in hyperlipidemic rats (Lee *et al.,* 2010). In addition, phenolic extracts from pearl millet were evaluated for their inhibitory effects on lipid peroxidation in *in vitro* copper-mediated human LDL cholesterol oxidation and several food model systems, namely, cooked comminuted pork, stripped corn oil, and a linoleic acid emulsion. At a final concentration of 0.05 mg/mL, millet extracts inhibited LDL cholesterol oxidation by 1% to 41%. All varieties of pearl millet exhibited effective inhibition of lipid oxidation in food systems used in this study and similar to butylated hydroxyanisole at 200 ppm (Chandrasekara and Shahidi, 2012).

Pearl Millet against cancers

Pearl Millet grains based on literature values are known to be rich in phenolic acids, tannins, and phytate that act as "antinutrients" (Thompson, 1993). However, it has been established that these antinutrients reduce the risk for colon and breast cancer in animals (Graf and Eaton, 1990). It has also been reported that populations consuming sorghum and millet have lower incidences of esophageal cancer than those consuming wheat or maize (Sharma and Kapoor, 1996). Furthermore, a recent study has demonstrated that millet phenolics may be effective in the prevention of cancer initiation and progression *in vitro* (Chandrasekara and Shahidi, 2012).

Pearl Millet and celiac disease

The overall growing demand for novel, tasty, and healthy foods, together with the increasing number of people suffering from celiac disease, has given birth to a new market consisting of cereal products made from grains other than wheat and rye. In this challenging market pearl millet has gained a special position (Angioloni and Collar, 2012). Celiac disease is an immune-mediated enteropathy triggered by the ingestion of gluten in genetically susceptible individuals. It is one of the most common lifelong disorders worldwide. In the past, celiac disease was considered a rare disorder, mostly affecting children of European origin. Recently, a huge number of studies have shown that celiac disease is one of the commonest lifelong disorders affecting humans in many areas of the world (Catassi *et al.,* 2007). A gluten-free diet primarily affects food consumption from the grain food group. In place of wheat, barley, and rye-based foods, persons adhering to a gluten-free diet must consume foods made from gluten-free grains, including pearl millet, rice, corn, sorghum, amaranth, buckwheat, quinoa, wild rice, and oats (Tripathi, 2010). 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. However, since millets are gluten-free, they have considerable potential in foods and beverages that can be suitable for individuals suffering from celiac disease (Chandrasekara and Shahidi 2012).

Product development

For improvement of the nutritive value of food and diet to avoid malnutrition and certain diseases, different approaches are needed to offer adults and children improved food with low-cost and locally available food formulations. Pearl millet was used with amaranth and buckwheat in the manufacture of extruded breakfast cereal products as a replacement for wheat and maize flour. The results showed that the use of these flours altered the physical and nutritional quality of extruded breakfast cereals. Further, all of the extruded products made with the inclusion of pseudo cereals showed a significant reduction in readily digestible carbohydrates and slowly digestible carbohydrates compared to the control product during predictive *in vitro* glycemic profiling (Brennan *et al.,* 2012).

Development of pearl millet and rice based gluten free chapatti

MATERIALS AND METHODS

The present investigation was conducted in the Department of Foods and Nutrition, I.C College of Home Science, CCS Haryana Agricutural University, Hisar.

Procurement of material

Pearl millet (HC-20 variety) was procured from the Department of Plant Breeding, CCS Haryana Agricultural University, Hisar, while amaranth leaves and Soybean were procured from the local market due to unavailability at respective research centres. All the raw ingredients were cleaned, washed well under running tap water to get rid of all the dirt, soil, and foreign matter prior to product development. Raw materials were then dried and stored in clean and hygienic condition for further use.

Development of pearl millet and rice based gluten free multi grain chapatti

In the present study pearl millet and rice based *Chapati* was developed along with value addition of soy bean and amaranth grains using three ratios of pearl millet: rice i.e 25:75, 50:50, 75: 25. Soya bean flour was added to increase the protein content of product. To improve the calcium and iron content of products amaranthus grain powder was supplemented in the product.

S. no.	Ingredients	I	II	III
1.	Pearl millet flour (g)	20	40	60
2.	Rice flour(g)	60	40	20
3.	Bengal gram flour (g)	20	20	20
4.	Amaranth leaves powder(g)	5	5	5
5.	Water(ml)	80	80	80
6.	Salt(g)		½ tsp	

METHOD

- Prepared soft dough of flour with addition of salt and water.
- Divided dough into equal portions, made into small balls and rolled out with the help of rolling pin.
- Cooked *Chapati* on a hot griddle from both the sides until brown.
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Sensory evaluation of developed value added pearl millet and rice based Chapati

Developed product was organoleptically evaluated by a panel of ten judges from I.C College of Home Science, CCS Haryana Agricultural University employing 9-Point Hedonic Scale. Average of scores for all sensory characteristics, viz., color, appearance, flavor, texture, taste was expressed in terms of overall acceptability.

RESULTS AND DISCUSSION

The developed *Chapati* was found to be acceptable to the palates of the panelists with mean scores of organoleptic acceptability falling in the range of 'liked moderately'. Results presented in Table 1 indicated that scores for overall acceptability of Type I and Type II were in the category of 'liked moderately', whereas overall acceptability of Type III *Chapati* was in the range of 'liked very much' for overall acceptability.

Table 1 Mean scores of organoleptic acceptability of pearl millet and rice based *Chapati*

Product	Color	Appearance	Aroma	Texture	Taste	Overall acceptability
Type-I(P:R::25:75)	7.3±0.14	7.3 ±0.15	7.2±0.14	7.0±0.21	7.0±0.23	7.2±0.15
Type-II(P:R::50:50)	7.5±0.20	7.4±0.15	7.4±0.15	7.2±0.19	7.2±0.19	7.4±0.16
Type-III(P:R::75:25)	7.9 ±0.28	7.9 ±0.28	7.9±0.28	8.1±0.25	8.1±0.28	8.0±0.27
CD(P<0.05)	0.61	0.59	0.59	0.63	0.69	0.58

Values are mean ± SE of ten observations
P: Pearl millet R: Rice

Studies were conducted on human diabetics (male and female) living in different rural and urban locations in India, and 13 diabetics were selected and asked to replace their regular wheat *chapati* with multigrain *chapati* (millet and wheat in a 30:70 ratio). The sugar level in high-glucose persons was lowered by continuous consumption of multigrain flour. All persons who consumed the multigrain *chapati* were found to have considerably decreased blood glucose levels (Pradhan *et al.,* 2010). Therefore, pearl millet grains have potential to be useful for diabetics.

CONCLUSION

Although nutritive value and potential health benefits of pearl millet grains are comparable to major cereals such as wheat, rice, and maize utilization of millet grains as food is still mainly limited to populations in rural areas at the household level. Providing more healthful and traditional whole-grain and multigrain substitutes for refined carbohydrates can be one important aspect of therapeutic dietary modification and promotion of utilization of pearl millet. In order to increase consumption of pearl millet and utilize its tremendous nutritional potential, diversification of food production and consumption must be encouraged both at national and household levels in tandem with increasing yield.

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