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Research Article

GLUTEN- FREE PINNI: A HEALTHY SUSTAINABLE FOOD

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ABSTRACT

Purpose: The research study was undertaken to develop and assess the nutritional characteristics and sensory parameters of a low cost, gluten-free multigrain pinni- an indigenous north Indian cuisine served as a dessert and is made from clarified butter (desi ghee), wheat flour, sugar and almonds. Since this sweet is a popular dish and commonly consumed food an attempt was made to formulate the above dish using millets and legume flours in different proportions to the standard recipe in order to provide a nutritional rich healthy snack to the health conscious individuals and celiac patients. The millets and grains so selected are nutritionally balanced with a judicious mix of versatile essential nutrients like protein, calcium, iron, fiber, are low in fat and have less impact on the environment as they requires less water for irrigation, minimum to no chemical fertilizers and can easily survive in stressful conditions; hence they are an ideal organic cultivation great for both health and environment sustainability.

Methodology: Multigrain pinni was prepared by incorporating finger millet, sorghum, and buckwheat and chickpea flour along with chiaseeds, flaxseeds and sesame seeds. These pinnis so formulated were analysis for their nutrient content viz. moisture, ash, fiber, carbohydrates, fat, protein, calcium and iron. Sensory analysis, on a 9-point hedonic scale was also performed to assess their acceptability.

Findings: The multigrain pinnis showed high protein content 16.57%, along with appreciable amounts of calcium, 9.86%. The acceptability of the product on 9-point hedonic scale obtained a score of 7.03 which showed that it is an acceptable product and can be introduced as healthy food alternative for celiac patients and others allergic to wheat grain protein –gluten.

Social implications: This value added product has high protein and mineral content, especially, calcium content was significant. This health promoting functional food product serves as a potential sustainable food of the future and hence, ensures food security and well being of people suffering from gluten intolerance.

INTRODUCTION

Food is an intersection point where the spheres of health and the environment intersect. Food not only plays an important role affecting individual health, but also has an impact on the environment and its resources. Dietary changes can significantly contribute to environmental sustainability and individual health. With change in global climate and diminishing world resources, there is a growing focus on the concept of a sustainable diet and its interface with health and nutrition. Sustainable healthy diet is one that provides all essential nutrients from food products that have low environmental impact, it focuses on incorporating more foods from the base of the food pyramid like the inclusion of more of millets, legumes, whole grains and fruits and vegetables that have good impact on the environment and human nutrition and health, with animal products eaten sparingly (Yenagi *et al*.2010).

Wheat, a cereal grain is the most common and popular staple food worldwide, contains on an average 12% to 14% gluten- a storage protein found in cereal grains like rye, wheat, and barley and related hybrids, which is responsible for triggering an immune response in genetically predisposed individuals causing celiac disease. Celiac disease (gluten sensitive enteropathy) is a serious autoimmune disorder that affects

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primarily the digestive system and is characterized by chronic inflammation of the small intestinal mucosa that subsequently causes atrophy of the intestinal villi leading to malabsorption of nutrients. The disease can occur at any age and classic symptoms include gastrointestinal problems like diarrhea, abdominal cramping, pain, and distention along with vitamin and mineral deficiencies, a few may manifest extra intestinal problems like iron deficiency anemia, joint pains, fatigue, skin disorders to mention a few.(Jnawali *et al*.2016; Tanwar *et al*.2017) . The mainstay of treatment for the celiac disease patients is to avoid gluten containing foods. A recent study by the experts at the All India Institute of Medical Sciences (AIIMS), estimates around 6-8 million people in India to be suffering from celiac disease. It is more common in the northern part of India with an estimated prevalence rate of 1.2 per cent. (Indiatimes, 2017).

According to a study by Institute of Agribusiness Management (IABM), the market share of gluten free products is expected to grow at 8.7% in the near future with the increase in the diagnosis of celiac disease and greater awareness of the nutritional and health benefits of gluten free products (Livemint,2017). Hence, a low cost multigrain *pinn*i using a blend of millets, legume and pseudo cereals were prepared and the product was assessed for its nutritional and sensory characteristics.

A detailed study of the nutritional profile of legumes reveals that the legumes contains high amount of proteins (18-32%) and are a rich source of essential amino acids like lysine and tryptophan besides containing appreciable amounts of micronutrients like iron, folate, magnesium etc.Owing to desirable functional properties like fat binding, water holding, and gelatinization that makes it an ideal product to be used in a wide variety of food products(Vaz-Patto *et al*.2015) and are therefore, considered as an ideal supplement to gluten-free diets as a functional ingredient (Tosh *et al*.2010). Chick Pea (*Cicer arietinum* Linn),is unique grain legume, it has a high content of protein (17%-30% by dry weight), fiber, fat and low amounts of carbohydrate. High protein digestibility along with being rich in mineral-vitamin like folic acid, zinc and B group of vitamins and is relatively free from anti- nutritional factors (7,8), makes this versatile anti inflammatory legume with a nut like flavor makes it suitable choice for incorporation in the food of celiac patients and therefore, being used as gluten- free alternative in this formulation.

Millets (Ragi, Sorgham etc) are rich sources of dietary fiber, micronutrients and phytochemicals of nutaceutical importance that help sustain and promote health. Research support and provide evidence that phytochemicals are beneficial against cancer, heart disease, inflammation, ulcers and infections etc. all so commonly seen in celiac patients, and hence inclusion of millets like ragi, jowar, can benefit the celiacs.(Dillard and German,2000) along with being a good sources of essential amino acids especially methionine (Singh *et al*.2012).

Buckwheat (*Fagopyrum esculentum*), a pseudocereal, is a traditional crop cultivated in most parts of the world that can survive under most harsh environments (Arendt *et al*.2006). Buckwheat is used in the production of not only gluten-free products suitable for consumption by celiac disease patients but also as an alternative nutritive rich food source for the general consumption. (Gallagher *et al*. 2004). Another widely used millet for the development of value added products is Ragi (*Eleusiune coracuna*) – a minor millet crop with high quality nutrition at low cost. It is a rich source of calcium, protein and including soluble and insoluble dietary fiber, flavonoids, polyphenol, and sulfur containing amino acids methionine (Vijayalakshmi *et al*. 2003; Gull *et al*. 2014).

Due to the above attributes, these grain crops have been selected in the present study for the formulation of acceptable and nutritious gluten-free *pinni*, as they have the potential nutritional attributes that can have significant health benefits when incorporated into food of celiac patients, as gluten-free nutrient dense functional foods along with maintaining sustainability of the ecosystem.

MATERIALSANDMETHODS

Procurement of Raw Material

For the preparation and development of *pinni*, the required materials *viz*. Chick Pea flour, Finger Millet Flour, Sorghum flour, Buckwheat flour, Canola oil, Chiaseeds, Flaxseeds, Sesame seeds, Almonds, Coconut powder, Sugar, Cardamoms and Ghee were purchased from the local market of Ferozepur, Punjab, India.

The flours were dry roasted at low heat for 3 to 4 minutes at 180°C, roasting improves the nutrient profile by increasing the in-vitro digestibility of carbohydrates and proteins and reduces the anti nutritional compounds such as heat liable protease inhibitors (Muzquiz *et al*.2012), besides imparting a nutty flavor to the product. It was cooled, sieved through a 1mm sieve. Packed in airtight containers and stored at room temperature (25°C) till further use. The nuts and seeds were also dry roasted and finely chopped for incorporation in the recipe.

Preparation of Composite Flour Pinni

Three different samples of *pinni* were prepared with the incorporation of different proportions of gluten free flours mix, the flour blend description is given in Table 1. Table 2 shows the ingredients used in the preparation while Figure 1 shows the flow chart for the *pinni* preparation.

Chemical Analysis

The formulated *pinni* samples were grounded to a fine powder in a pestle-mortar and oven dried at 60±2°C. The dried samples were again grounded to fine powder for further chemical evaluation. Moisture, protein, fat, crude fiber, ash, carbohydrate, iron and calcium were estimated according to the protocols as mentioned in AOAC (2000) methods. While carbohydrate content of the product was calculated by subtracting the moisture, protein, ash, fiber and fat values from 100. The protein determination, nitrogen content was measured by micro-Kjeldahl method and converted to protein value using factor 6.25.

Sensory Analysis

The samples were evaluated on a 9-point hedonic scale by the semi-trained panelists (Ranganna,1996). Fifteen panelists tasted the product and rated their preferences in terms of appearance, aroma, taste, texture and overall acceptability. The maximum score of nine was considered as excellent, while a score of 1 was least preferred and categorized under poor

acceptability, the intermediate scores of (2,3,4) were fair while (5,6) was considered as good acceptability and (7,8) as desirable or very good acceptance .

Statistical Analysis

The chemical and sensory scores of each sample were further statistically analyzed using Graph Pad Prism 5 Software. Mean values and standard deviation for each sample were calculated. One-way analysis of variance, followed by Turkey's test, was applied to test the significant difference between the various formulations and levels of supplementation in terms of its nutritive value and acceptance.

Table 1 Flour blend description: Different combination of Chickpea flour, Buckwheat flour, Finger millet flour and Sorghum flour

Flour blend	Chickpea flour (CPF), %	Buckwheat flour(BWF), %	Finger millet flour(FMF),%	Sorghum flour (SF), %
AA	75	25	-	-
AB	50	25	25	-
AC	50	20	20	10

Table 2 Composite flour *Pinni*: Formulation and Preparation

Ingredients (in g)	AA	AB	AC
Chickpea flour	75	50	50
Buckwheat flour	25	25	20
Ragi flour	-	25	20
Jowar flour	-	-	10
Flaxseeds	20	20	20
Chiaseeds	20	20	20
Sesame seeds	10	10	10
Coconut+almonds	10+10	10+10	10+10
Cardamom	7	7	7
Brown sugar	100	100	100
Clarified ghee	60	60	60

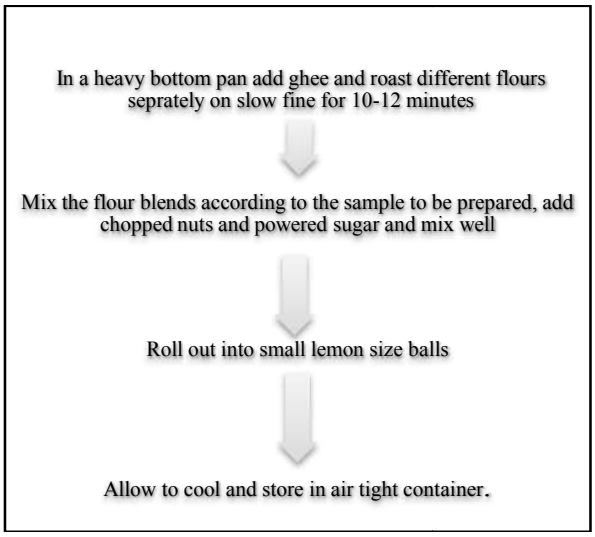

Fig 1 Flow chart showing the step wise preparation of composite flour*pinni*.

RESULT AND DISCUSSION

Nutritional Composition of Composite Flour pinnis

Nutritional composition of the product is presented in Table 4, an overview of the scores shows an increase in ash, fiber, calcium, iron and carbohydrate content with increase level of incorporation of the different flours. Similar results were reported in a study on formulation of noodles using millet flour and pulse flour (Thilagavathi *et al*.2015).

A significant difference ($p<0.05$) between the moisture content of *pinnis* made from different proportions of flour blends and chick pea flour was observed and it ranged from 6.7 to 5.53per cent. The ash content is the amount of inorganic minerals present in a food. the ash content of the *pinni* showed a significant difference and ranged from 12.07 to 8.36 per cent, similarly the percentage of protein in the samples ranged from 20.63 to 16.57 percent, illustrating a significant difference ($p<0.05$).Similar results were reported by Thongram *et al* (2016). Since legumes and millets contain good amounts of high quality proteins, hence supplementation of a food product with millets and pulses can significantly improve food quality, especially its protein and mineral content.

Fat content of a product not only improves the appearance of the product but also its overall quality and acceptability. The fat scores of the *pinni* samples ranged from 11.2 to 9.53 percent, with a significant difference. The fiber content of the formulated product also illustrated a significant difference, ranging between 3.6 to 4.06 per cent. The highest fiber percentage being in AB (4.06) and lowest in AA (3.6). The carbohydrate content of the *pinnis* ranged from 60.07 to53.45 per cent. The two minerals analyzed namely, iron and calcium scores ranged from 9.1 to 9.76 and 8.67 to 9.86 percent, respectively. The high values of the iron and calcium content of the developed products can be due to the supplementation of the product with finger millet and sorghum flour.

Table 4 Nutritional composition of composite flour *pinnis*

Parameters/Sample	AA	AB	AC
Moisture	6.70 ± 0.10^{a}	6.10 ± 0.17^{b}	5.53 ± 0.05^{c}
Ash	12.07 ± 0.06^{a}	11.17 ± 0.15^{b}	8.36 ± 0.23^{c}
Protein	20.63 ± 0.47^{a}	18.47 ± 0.05^{b}	16.57 ± 0.11^{c}
Fat	10.25 ± 0.25^{a}	9.53 ± 0.05^{b}	11.20 ± 0.3^{c}
Carbohydrates	50.60 ± 0.70^{a}	54.80 ± 0.20^{b}	58.33 ± 0.30^{c}
Crude Fiber	3.6 ± 0.1^{ac}	4.06 ± 0.12^{bc}	3.80 ± 0.26^{c}
Calcium	8.67 ± 0.15^{a}	9.30 ± 0.52^{ab}	9.86 ± 0.32^{b}
Iron	9.10 ± 0.29^{a}	9.63 ± 0.12^{ab}	9.76 ± 0.25^{b}

Note: Values are Mean ± SD ; values with different superscripts in the same row are significantly different ($p<0.05$) level.

Sensory analysis of composite flour pinnis

Sensory evaluation serves as a tool to determine the quality and organoleptic acceptability of a food product by measuring and analyzing human responses to the composition of food in terms of Appearance, aroma, texture, taste and acceptability.

Panelists used a Nine point hedonic scale to evaluate the acceptability of the product.. The scores of the sensory evaluation is tabulated in Table 5. In terms of overall acceptability a significant difference ($p<0.05$) was observed between sample AA (6.13) and AB (6.47) samples, while AC flour blend sample showed most acceptability (7.03). The stastitical values of taste and texture, of the three samples showed no significant difference ($p<0.05$). In terms of acceptability for taste, the values ranged from 7.49 to 6.59 with AC being the tastiest (7.49) and AA the least preferred in terms of taste (6.59). The reason as cited by the panelists was that the *pinni* made from the blend of 4 grains had a sweet taste that was different and appetizing. The maximum score for texture was observed in AB (7.12) and minimum in AC (6.41) as it was a bit dry due to the addition of the coarse grains.

Table 5 Sensory characteristics of composite flour *pinnis*

Parameters/Sample	AA	AB	AC
Appearance	7.60 ± 0.44^{a}	6.90 ± 0.57^{b}	6.85 ± 0.42^{b}
Aroma	7.39 ± 0.39^{a}	7.05 ± 0.35^{ab}	6.86 ± 0.40^{bc}
Taste	6.59 ± 0.53^{a}	7.15 ± 0.59^{bc}	7.49 ± 0.51^{bc}
Texture	6.78 ± 0.47^{a}	7.12 ± 0.39^{ab}	6.40 ± 0.53^{ac}
Overall acceptability	6.13 ± 0.55^{a}	6.47 ± 0.41^{ab}	7.03 ± 0.44^{c}

Note: Values are Mean ± SD ; values with different superscripts in the same row are significantly different ($p<0.05$) level.

CONCLUSION

Changing climate and growing population have increased the burden on the agriculture sector. Also, the incidence of food intolerance is on a rise, especially the incidence of celiac disease that has put an increasing demand on the easy availability of nutritionally adequate gluten free products. Hence, to maintain the equilibrium of the ecosystem and to feed the ever increasing population, the prolific approach to overcome this threat is by substituting gluten containing cereals with legumes and millets in order to obtain sustainable foods with high nutrients and nutraceuticals. The above gluten-free product so formulated by a blend of different proportion of chickpea flour along with ragi, jowar and buckwheat resulted in the development of a low cost, acceptable product with a good nutritional profile, a healthy nutritious food for the celiac patients.

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Conflict of Interest

There is no conflict of interest in the publication of this research paper.

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