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CONTENTS

Nutritional and sensory evaluation of gluten free chapatti developed using underutilised food sources

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ABSTRACT: The present study aimed to develop nutritious gluten free chapatti and to improve its nutritional value using underutilized millet and legume like barnyard millet and horse gram along with the rice flour and sesame seeds. The developed gluten free chapatti was subjected to nutritional and sensory analysis and compared with the control wheat flour chapatti. Nutritional composition analysis consisted of proximate analysis and estimation of iron content. The results revealed that ash (2.60%), protein (15.29%), fibre (4.21%), fat (2.91%) and iron (9.83mg/100g) content of gluten free chapatti was significantly higher than that of ash (1.57%), protein (10.29%), fibre (3.05%), fat (1.87%) and iron (2.85mg/100g) content of control wheat flour chapatti whereas the carbohydrate content (79.17%) of gluten free chapatti was significantly lower than that of wheat flour chapatti (86.14%). Although the sensory score for gluten free chapatti were significantly lower in comparison to control wheat flour chapatti but the sensory scores for gluten free chapatti were as well acceptable. This showed that gluten free chapatti with good nutritional and acceptable sensory properties can be prepared and could be a good alternative for people suffering from gluten intolerance or celiac disease.

Key words: Barnyard, celiac disease, chapatti, gluten intolerance, gluten free, horse gram, sesame seed

Chapatti, the ûat unleavened baked product generally prepared from whole wheat ûour, is the oldest, most consumed and main traditional staple food consumed by a majority of the population in the world and Indian sub-continent (Wani *et al.*, 2016; Agbara *et al.*, 2018). Whole wheat flour has unique profile to form cohesive dough with the ability to trap gas and allow for mechanical sheeting because of presence of gluten (Landillon*et al.*, 2008). However, some individuals suffer from gluten intolerance known as celiac disease (CD). Celiac disease is considered as chronic gut disorder that can happen in genetically predisposed people where the consumption of gluten in diet can damage the lining of the small intestine which being asymptomatic lead to causing severe malnutrition (Jnawali*et al.,* 2016). Once thought to be a rare disease it is now a global disease and affects almost 1% of the world's population (Rewers, 2005; Fasano *et al.*, 2003). The Age-adjusted prevalence of celiac autoantibodies was 1.23% in northern, 0.87% in northeastern, and 0.10% in southern India (P<0.0001) (Ramakrishna *et al.,* 2016). The prevalence of seropositivity (anti-tTG ab) was 1.44% (1 in 69) indicating that approximately 5–8 millions of Indians were expected to have CD(Makharia*et al.*, 2011). Currently restriction or total omission of gluten from the diet is the sole alternative (Ludvigsson *et al.*, 2014; Mansueto *et al.,* 2014) and it is advised to adopt gluten-free protein diet to manage CD (Wieser & Koehler, 2008; Raymond *et al.*, 2006). Thus, the demand and consumption of gluten-free food has increased (Lee *et al.,* 2007).

However, some patients on a long term gluten free diet may exhibit clinical features possibly related to nutrient deficiencies (i.e. iron, fibre, folate, protein, zinc, calcium) as GFD is found to be unbalanced in various micro and macronutrients (Kupper, 2005; Caruso *et al.*, 2013; Hosseini *et al.*, 2018) andmost of gluten-free products available in market are using starch or refined gluten-free flour, so these products remained only the rich sources of starch and fat if not fortified with essential nutrients (Moreno *et al.*, 2014).As millets, legumes and oilseed are gluten free thus these are appropriate food for those with CD or other forms of allergies or wheat intolerance (Saravana and Soam, 2010). They can be used to produce gluten-free chapatti of high nutritional value. Among millets barnyard millet (*Echinochloafrumantacea*)is a rich source of protein (11.2–12.7%), fiber, vitamins and most notably micronutrients like iron (15.6–18.6 mg/100 g) and zinc (4.1 mg/100 g). Along with the iron content its bioavailability is also necessary and it has been observed that meals prepared with high iron millets had high bioavailable iron that can provide 100% of the physiological requirement of iron as proposed by ICMR (2020) (Anitha *et al.,* 2021). Horse gram (*Macrotyloma uniflorum*) is one of the underutilized legume and inexpensive source of protein, calcium and iron. Sesame seed (*Sesamum indicum*)is high in protein, vitamin B1, dietary fiber as well as an excellent source of phosphorous, iron, magnesium calcium, manganese, copper and zinc (Manthey *et al.,* 2002).

The replacement of gluten presents a major technological challenge, as it is an essential structure-building protein. To tackle this problem, hydrocolloids like xanthan gum and guar gum can be incorporated in gluten-free flour to mimic the viscoelastic properties of gluten (Lazaridou *et al.*, 2007). The relatively small amount of prolamin in rice, forces to use some sort of gum, emulsifier, enzymes or dairy products, together with rice flour, for obtaining some viscoelastic properties (Demirkesen *et al.*, 2010).

Therefore, the present study aim to develop nutritious gluten free chapatti comprising barnyard millet flour (BMF), horse gram flour (HGF), sesame seed (SS) and rice flour (RF).

MATERIALS AND METHODS

Locale of the study
The study was conducted in the Department of Food Science and Nutrition, College of Home science, GBPUAT, Pantnagar.

Procurement of sample
Barnyard millet, horse gram, sesame seed and rice flour (Vijay rice flour) were purchased from the local market of GBPUAT, Pantnagar.

Cleaning and Processing of Grains
The grains were cleaned manually to remove any foreign substance such as damaged seeds, dust particles, stones, metal and glass pieces. The barnyard millet, horse gram and sesame seed were ground to make flour using Bajaj Rex 750W Mixer Grinder.

Preparation of composite flour
Composite flour was prepared by mixing 50g of barnyard millet, 30g of horse gram, 10g of rice flour, 10g of sesame seed and 2g of xantham gum. All the levels of ingredients were decided on the basis of sensory evaluation.

Preparation of chapatti
Chapattis were prepared by following the method as reported by previous researchers (Rao and Bharati, 1996; Kadam *et al.,* 2012) with slight modifications. The chapatti dough was prepared by mixing composite flour (BMF, HGF, RF and SS) with the pre-determined optimum amount of water (75 ml) and was kneaded until the dough became soft. The dough was covered with a wet cloth and was set aside to rest for 30 minutes at room temperature (25± 5ºC). The dough was divided into equal portions of 40 gm each and rolled into a round sheet (10 cm in diameter and about 2 mm in thickness). The chapattis were baked in a hot induction plate at 210± 5ºC for 150 seconds on each side and puffed over the flame for 30 sec. After baking, chapattis were cooled at room temperature.

Nutritional composition
Nutritional composition analysis consisted of proximate analysis and estimation of iron content. Proximate analysis and iron content of the chapatti was performed by adopting standard AOAC methods (AOAC, 2012). Moisture content was determined using hot air oven method; crude protein by Micro-Kjeldahl method; crude fat by Soxhlet extraction method; crude fibre by neutralization method and ash content by dry ashing method. Carbohydrate content was calculated by difference method. Total carbohydrate (%) = 100 - % (moisture + protein + fat + ash). The physiological energy of the sample was calculated by adding the product of crude

protein %, crude fat %, and carbohydrate present in the sample by 4, 9, and 4, respectively. The physiological energy was expressed in Kcal/100g.

Sensory analysis

The chapatti samples were evaluated in terms of color, appearance, taste, texture and overall acceptability by a total of 10 semi-trained panelists from the Department of Foods and Nutrition, College of Home Science, GBPUAT, Pantnagar. The samples were evaluated using score card method (Amerine *et al.,* 2013) representing scoring scale as 1-2 very poor, 3-4 poor, 5-6 fair, 7-8 good, 9-10 very good. The sensory laboratory was well equipped with good lighting, airflow and was odorless.

Statistical analysis

Results generated in this study were expressed as mean ± standard deviation of three independent replications. The statistical significance of the generated results was obtained using WASP software. Differences at $p<0.05$ were considered to be significant.

RESULTS AND DISCUSSION

Nutritional composition

The proximate composition and the iron content of the gluten free chapatti and wheat flour chapatti are depicted in Table1. From the results, it was observed that gluten free chapatti contained moisture (25.09%), ash (2.60%), protein (15.29%), fibre (4.21%), fat (2.91%) content which were significantly higher than that of moisture (22.09%), ash (1.57%), protein (10.29%), fibre (3.05%), fat (1.87%) content of wheat flour chapatti served as control. The carbohydrate content (79.17%) of gluten free chapatti was significantly lower than that of wheat flour chapatti (86.14%). Higher ash, protein and fibre content in gluten free chapatti was due to the presence of, barnyard millet, horse gram and sesame seed as incorporation of millets, legumes and oilseeds enhance the micronutrient content (Sobia *et al.,* 2017). Also, the legumes are usually rich in protein as compared to cereals and barnyard millet is an excellent source of dietary fibre(Veena *et al.,* 2010). The findings were in contrast to a study by Kumari (2019), who created gluten-free chapatti using a combination of rice flour, corn flour, and sago flour in three different proportions and discovered significantly lower values for protein (5.10-6.42%) and ash (0.68-0.95%) content and significantly higher values for carbohydrate (56.71-58.19%) and fat (4.58-4.80%) when compared to wheat flour chapatti. Cheng and Bhat, (2015) performed proximate analysis of wheat flour chapatti and chapatti made from 100% jering seed flour and observed higher protein content (15.5%) and ash content (2.32%) in jering seed flour chapatti when compared to wheat flour chapatti having protein and ash content 11.45% and 1.77%, respectively.

The iron content (9.83mg/100g) in gluten free chapatti was significantly higher than iron content (2.85mg/100g) of control wheat flour chapatti due to the presence of high iron containing millet i.e. barnyard millet and also the horse gram which is a good source of iron content among legumes. Jeanes *et al.* (2022) conducted a study on estimation of mineral content in the wide range of bread items selected from the market and observed that the iron in gluten free bread loaves and pasta samples was similar to wheat-based comparators, whereas lower iron levels were observed in gluten free wraps (0.8 ± 0.2 n = 11 versus 1.6 mg/100 g).

Sensory analysis

Gaining favorable sensory characteristics is a tremendous challenge in developing GF products. GF products exhibit different appearances, colors, texture, aroma, and taste compared to wheat flour products (Yildiz andGocmen, 2021). The sensory scores of gluten free chapatti and control wheat flour chapatti are depicted in Table 2. All the sensory parameters of gluten free chapatti were statistically lower than that of wheat flour chapatti but the scores depicted good overall acceptability (7.95) of the gluten free chapatti. Chapatti of good overall quality should possess an appealing color with light brown spots spread evenly over the surface, a smooth, soft and pliable hand feel, the desired soft chewing quality and sweetish taste. It should be optimally baked and puffed so as to impart a pleasant wheaty aroma (Khurshid *et al.,* 2020). Similarly,Cheng and

Table 1: Nutritional analysis of gluten free chapatti and wheat flour chapatti on dry weight basis

Parameters	Gluten free chapatti	Wheat flour chapatti
Moisture (%)	25.09± 0.20^{a}	22.09± 0.56^{b}
Ash (%)	2.6± 0.21^{a}	1.57± 0.01^{b}
Protein (%)	15.29± 0.36^{a}	10.29± 0.35^{b}
Fibre (%)	4.21± 0.26^{a}	3.05± 0.12^{b}
Fat (%)	2.91± 0.25^{a}	1.87± 0.06^{b}
Carbohydrate (%)	79.17± 0.28^{b}	86.14± 0.41^{a}
Physiological energy (Kcal/100g)	403.97± 2.13^{a}	403.65± 1.39^{a}
Iron (mg/100g)	9.83± 0.65^{a}	2.85± 0.30^{b}

Values are the mean of replications (n =3), ^{ab} values within the rowwith different superscript letters differed significantly ($p<0.05$) where, a>b

Table 2: Sensory analysis of gluten free chapatti and wheat flour chapatti

Parameter	Gluten free chapatti	Wheat flour chapatti
Color	8.05^{b}	8.35^{a}
Taste	7.95^{b}	8.30^{a}
Texture	8.15^{b}	8.45^{a}
Flavor	8.00^{b}	8.35^{a}
Overall acceptability	7.95^{b}	8.25^{a}

^{ab} values within the row with different superscript letters differed significantly ($p<0.05$), where, a>b

Bhat (2015) compared sensory evaluation of control wheat flour chapatti and wheat-jering composite chapattis and observed that overall composite wheat flour chapattis were more acceptable by the sensory panelist followed by wheat-jering composite chapattis substituted with 5, 10, 15 and 20% of jering seed flour.

CONCLUSION

Underutilized grain viz., barnyard millet and legume like horse gram could be used to make nutritious gluten-free chapatti that is simple to make at home as well as in a commercial production. It can be every day staple for the celiac disease patients or person suffering from gluten intolerance or wheat allergy. Chapatti made from barnyard millet, horse gram, sesame seed and rice flour contained more amount of protein, fiber and iron content in comparison to wheat flour chapatti with good overall acceptability with regard to sensory evaluation. Overall, it can be concluded that gluten freechapatti with acceptable qualitative properties and good nutritive value can be prepared using underutilized sources.

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