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Research Article

Compositional and shelf-life analysis of developed instant Indian recipe *chilla mix* from hull-less barley: A convenience food product

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Abstract
Barley has a rich nutritional and therapeutic profile. In an era of life-style based silent pandemics, the need to bring on table the convenient food products with sensory and nutritional acceptability is necessary. Hence, the present study aimed to develop an instant *chilla mix* from a novel hull-less variety of barley (*Hordeum vulgare*) (PL891). Various random combinations of composite flour (barley flour (BF), rice flour (RF) and gram flour (GF)) were prepared namely T_1 (100:00:00), T_2 (70:15:15), T_3 (60:30:10), T_4 (33:33:33), and T_5 (00:00:100). Other ingredients such as onion, tomato, ginger, garlic, coriander, and chilli were also added. Nutritional and sensory parameters at fresh, three, six and nine month of storage interval were also analyzed. The assessed parameters (%) were reported as moisture (6.91±0.02 to 10.21±0.09), ash (2.11±0.05 to 3.10±0.02), protein (7.59±0.05 to 24.50±0.06), fat (1.50±0.02 to 6.10±0.04), crude fiber (1.08±0.02 to 2.87±0.02), and total carbohydrates (58.21±0.10 to 75.27±0.07). All the blends varied significantly ($p \geq 0.05$) during storage in terms of moisture, protein, fat, crude fiber, and carbohydrates, while a non-significant difference was noted in ash for all the treatments. Blending also affected the nutrient content of all the treatments significantly ($P \leq 0.05$) depending upon the ratio of blending and composition of various ingredients in the product. The sensory attributes indicated that T_2 blend with 70% PL891 hull-less barley flour was most acceptable. The developed product will be a nutritious substitute for chapati as barley is rich in numerous nutrients and have therapeutic potentials.

Keywords: Hull-less barley PL891, Instant *chilla* mix, Proximate composition, Sensory evaluation, Shelf-life

INTRODUCTION

Food's natural makeup and nutrient balance are the main factors determining its quality. In the modern-day lifestyle, where consumers' food choices are turning towards easier and instant products, the need to develop functional food products with the richness of nutrients is needed. The current available options for instant foods in the market are either not inclined towards the health benefits of consumers or are priced highly on the shelves with a short shelf-life. In the current study, efforts were made to develop an instant *chilla* mix with rich nutrient and healthy ingredients. The composite flour utilized for developing this food item had flour of a novel improved PL891 hull-less barley variety along with gram and rice flour in smaller quantities. According to various studies, all three components so utilized in the development of instant *chilla* mix are quoted as therapeutically effective. Barley has been stated to have anti-diabetic, anti-cancer, anti-obesity, anti-hyperlipidemic, and anti-adipogenic activities (Aludatt *et al*., 2012; Rendell et.,2005; Ikegami *et al*.,1996; Tok *et al*.,2021; and Lee *et al*., 2022). Barley, the keen focus for this instant *chilla* mix development has a rich nutrient profile (%) having moisture, total ash, crude fat, crude fiber, protein, and carbohydrates (Rani *et al*., 2020). Barley is also determined to have a rich micronutrient profile with calcium, magnesium, iron, and potassium as per the nutrient evaluation of Rihane, Manel, Roho, and Tej barley varieties (Lahouar *et al*., 2016). These macronutrients, if deficient, are responsible for endless deficiency related disorders and onset of non-communicable diseases such as osteoporosis, rickets, bone deformities, anemia, diabetes, hypertension, and cardiovascular diseases, which are engulfing both health and economic status around the globe (Deepika *et al*., 2023). Suppose healthier functional food options are available on shelves with an efficient shelf life, nutrient profile, and cost-effectiveness. In that case, market trends might be changed drastically along with the shift in the health of consumers in terms of prevention of various non-communicable diseases that are engulfing the majority of the population around the globe, threatening both the health and economy of almost every nation (Deepika *et al*., 2023). Hence, efforts were made to develop this convenience food product, which will turn out to be a healthier, easier, and less time-consuming alternative for chapati/roti in the busy lives of the modern-day world. Similar efforts to develop other convenience food products from barley, such as soup mix, flakes and biscuits were also made in some studies (Sonkar *et al*.,2015and Sundberg *et al*., 1994). The study was conducted to develop convenient functional food products and study their shelf life using novel hull-less barley variety (PL891).

MATERIALS AND METHODS

The work was carried out in the Food Research Laboratory, Department of Nutrition Biology, Central University of Haryana (India) to develop an instant *chilla* mix. For the preparation of *chilla* mix, gram and rice flour were collected from the local market of Mahendergarh, whereas the barley flour of procured hull-less barley variety, i.e., PL891 from ICAR-IIWBR (Indian Institute of Wheat and barley Research, Karnal, Haryana). The chemicals used in this investigation were analytical and obtained from Sigma-Aldrich pharmaceutical chemicals.

Processing of raw material

Initially, the raw materials were cleaned manually to remove dirt, dust, damaged or rotten ingredients, and foreign matter. The hull-less barley grains (PL891) were then sorted and moistened to 14% moisture for 24 hrs. The moistened grains were further homogenized into fine flour using a mixer grinder in the laboratory. The obtained barley flour was then packed in vacuum zip lock bags and stored in airtight containers at room temperature in dark condition till analysis and use. Gram flour (Rajdhani Flour Mills Ltd.) and rice flour (Ahaar company) were purchased from local markets in Mahendergarh, Haryana. Other perishable and semi-perishable ingredients such as tomato, onion, ginger, garlic and green chilly were purchased from the local mandi of Mahendergarh, Haryana. After initial processing, these items were kept in the hot air oven for drying at 45^0C for eleven, six, seven, eight and five hours, depending upon the time taken to attain stable weight after moisture loss of the ingredients. The obtained materials were then ground using a Maharaja white line smart mixer grinder 500 W into fine powders and stored separately in airtight containers. Spices namely coriander powder (catch foods) and salt (TATA) were also purchased from a grocery shop in Mahendergarh, Haryana.

Preparations of flour blends

For the development of the *Chilla* mix, the barley flour (BF) was blended with gram flour (GF) and rice flour (RF) in five different ratios (BF: RF:GF), i.e., T_1 (100:0:0), T_2 (70:15:15), T_3 (60:30:10), T_4 (33:33:33), T_5 (0:0:100), respectively. The salt, coriander powder, dried tomato, onion, green chilli, ginger, garlic and coriander powder were then added to the blends of obtained composite flour in a defined amount (Table 1). The final mixes were then roasted in a skillet for one to two minutes, then cooling and packaged in vacuum zip lock bags and stored in air-tight plastic containers for further use.

Table 1. Various treatments for blends of different flours with the amount of ingredients (gm)

Blends	Ratio (BF: RF:GF)	Barley flour (gm)	Rice Flour (gm)	Gram Flour (gm)	Salt (gm)	Coriander powder (gm)	Ginger / Garlic powder (gm)	Dried Onion/Tomato (gm)	Dried chili (gm)
T_1	100:0:0	100	-	-	5	5.66	2.5	16.65	3.3
T_2	70:15:15	70	15	15	5	5.66	2.5	16.65	3.3
T_3	60:30:10	60	30	10	5	5.66	2.5	16.65	3.3
T_4	33:33:33	33.33	33.33	33.33	5	5.66	2.5	16.65	3.3
T_5	0:0:100	-	-	100	5	5.66	2.5	16.65	3.3

Nutritional analysis of processed instant *chilla* mix

Prepared instant *chilla* mix was analyzed for moisture, ash, crude fiber, protein, fat and total carbohydrate content by following standard procedures of the Association of Official Analytical Chemists (AOAC, 2000).All the parameters for different blends were estimated for storage intervals of fresh, three, six and nine months of storage interval in triplicates and expressed as arithmetic averages.

Proximate composition

The samples were kept in weighed crucibles and kept in hot air oven at 105^0 Celsius until a constant weight was achieved. Weight loss after drying at 105^0 C was used to determine moisture content. Total ash content was calculated by incineration the prepared blends at 540^0C (dry ashing) for 4.5 hours. Crude protein (Nx6.25) was estimated by Kjeldahl apparatus. Fat content was estimated using the standard soxhlet method using automated soxhlet equipment using petroleum ether. Crude fiber was obtained by digesting the sample with 1.25% sulfuric acid and subsequently with 1.25% sodium hydroxide solution. Total carbohydrate was estimated by using the formula given below:

Total Carbohydrates (%) = [100 - (Moisture+Ash+Crude protein+Crude fat+Crude fiber)] Eq.1

Sensory evaluation

The sensory evaluation for color, texture, taste, aroma, and overall acceptability of instant *chilla* mix was performed to evaluate consumers' preferences using a nine-point hedonic scale (Larmond, 1977). Instant *chilla* mix was evaluated for sensory scoring by a semi–trained panel of 15 panellists from the Central University of Haryana, (India). The judges were trained for a period of one week considering the exclusion/inclusion criteria of being disease-free from cough, cold or any other interfering condition. After preparing the cooked reconstituted product from the instant *chilla* mix, the judges were served each preparation of blended samples. The instant *chilla* mix was reconstituted with 60mL of water/150 gm of *chilla* mix to form a homogenous batter, followed by cooking after spreading on a nonstick oil-greased pan on a low flame (Fig. 1). The samples were then allowed to cool down after cooking followed by coding to avoid any biased judgment. Judges were then asked to score the samples for color, texture, taste, aroma and overall acceptability.

Statistical analysis

The statistical analysis was performed using the SPSS software program to determine significant changes in obtained results between blends and storage intervals of fresh, three, six and nine months of storage interval at $p \le 0.05$.

RESULTS AND DISCUSSION

Nutritional composition and functional analysis

The nutrient composition of prepared instant *chilla* mix over the storage interval at fresh, three, six, and nine months is given in Table 2.

Moisture (%)

The moisture (%) of all the blends/treatments showed a significant increase with increase of storage interval with values ranging 7.87±0.05 to 9.60±0.10, 7.44±0.04 to 9.25±0.09, 6.97±0.07 to 8.90±0.07, 6.91±0.02 to 9.05±0.09, and 8.09±0.04 to 10.21±0.09 for blends T_1, T_2, T_3, T_4, and T_5 respectively. Meanwhile, blending also significantly affected moisture for various treat-

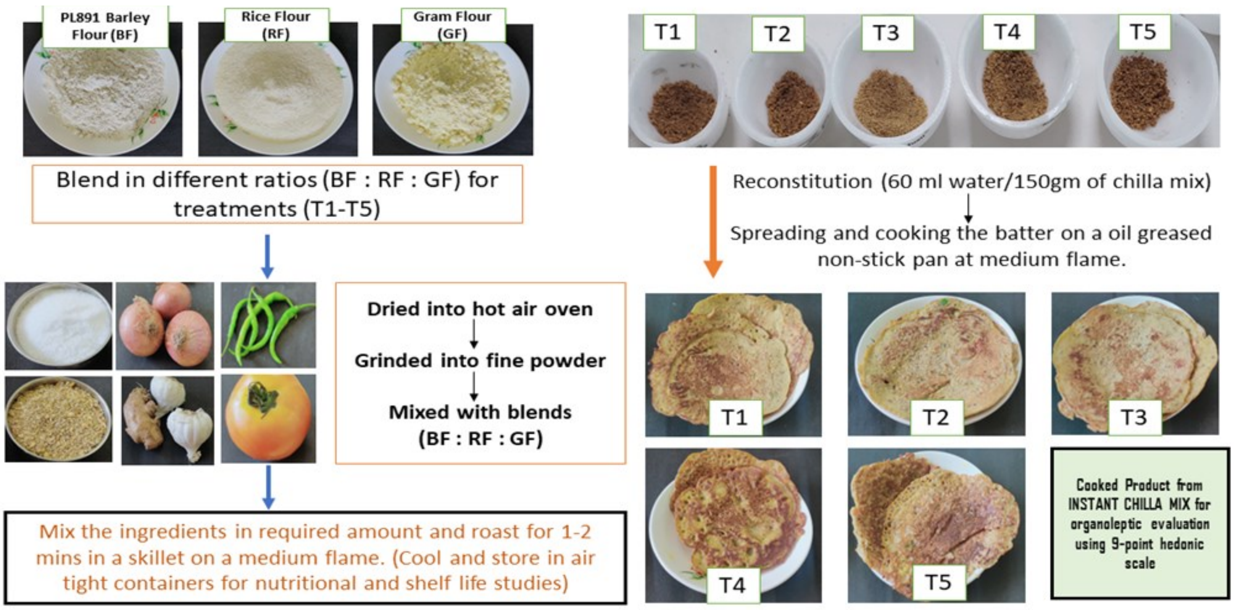

Fig. 1. *Graphical overview for preparation and quality evaluation of instant chilla mix*

Table 2. The nutrient composition of prepared instant *chilla* mix over the storage interval at fresh, three, six, and nine months

Parameter	Treatment /Blend	Storage interval			
		Fresh	3 month	6 month	9 month
Moisture (%)	T_1	7.87±0.05^{ae}	8.99±0.04^{be}	9.02±0.06^{ce}	9.60±0.10^{de}
	T_2	7.44±0.04^{af}	8.30±0.04^{bf}	8.71±0.07^{cf}	9.25±0.09^{df}
	T_3	6.97±0.07^{ag}	7.90±0.04^{bg}	8.25±0.07^{cg}	8.90±0.07^{dg}
	T_4	6.91±0.02^{ah}	7.82±0.04^{bh}	8.05±0.05^{ch}	9.05±0.09^{dh}
	T_5	8.09±0.04^{ai}	9.00±0.04^{bi}	9.31±0.04^{ci}	10.21±0.09^{di}
Ash (%)	T_1	2.22±0.01^{ab}	2.20±0.02^{ab}	2.19±0.02^{ab}	2.18±0.03^{ab}
	T_2	2.27±0.02^{ac}	2.25±0.03^{ac}	2.24±0.02^{ac}	2.22±0.03^{ac}
	T_3	2.14±0.01^{ad}	2.14±0.03^{ad}	2.12±0.03^{ad}	2.11±0.05^{ad}
	T_4	2.32±0.02^{ae}	2.31±0.02^{ae}	2.30±0.05^{ae}	2.28±0.05^{ae}
	T_5	3.10±0.01^{af}	3.10±0.02^{af}	3.09±0.04^{af}	3.08±0.05^{af}
Protein (%)	T_1	13.64±0.04^{ae}	13.25±0.10^{be}	12.91±0.06^{ce}	12.63±0.03^{de}
	T_2	14.21±0.04^{af}	13.76±0.04^{bf}	13.40±0.05^{cf}	13.11±0.08^{df}
	T_3	8.52±0.04^{ag}	8.18±0.03^{bg}	7.84±0.04^{cg}	7.59±0.05^{dg}
	T_4	14.90±0.04^{ah}	14.50±0.02^{bh}	14.15±0.04^{ch}	13.75±0.08^{dh}
	T_5	24.50±0.06^{ai}	24.05±0.05^{bi}	23.70±0.06^{ci}	23.25±0.10^{di}
Fat (%)	T_1	3.14±0.02^{ae}	2.16±0.02^{be}	1.71±0.02^{ce}	1.50±0.02^{de}
	T_2	3.30±0.02^{af}	2.40±0.02^{bf}	1.92±0.04^{cf}	1.68±0.02^{df}
	T_3	2.88±0.02^{ag}	2.77±0.02^{bg}	2.22±0.02^{cg}	1.97±0.05^{dg}
	T_4	3.50±0.02^{ah}	3.38±0.04^{bh}	2.78±0.04^{ch}	2.48±0.04^{dh}
	T_5	6.10±0.04^{ai}	5.95±0.04^{bi}	4.97±0.05^{ci}	4.57±0.05^{di}
Crude fibre (%)	T_1	2.87±0.02^{ae}	2.75±0.04^{be}	2.62±0.03^{ce}	2.30±0.03^{de}
	T_2	2.50±0.02^{af}	2.36±0.04^{bf}	2.25±0.02^{cf}	2.15±0.13^{df}
	T_3	2.44±0.02^{ag}	2.31±0.03^{bg}	2.21±0.02^{cg}	2.15±0.02^{df}
	T_4	2.04±0.02^{ah}	1.91±0.02^{bh}	1.81±0.03^{ch}	1.61±0.02^{dg}
	T_5	1.30±0.02^{ai}	1.17±0.02^{bi}	1.08±0.02^{ci}	1.06±0.02^{dh}
Carbohydrates (%)	T_1	71.16±0.06^{ae}	71.83±0.08^{be}	72.25±0.10^{ce}	72.30±0.07^{ce}
	T_2	71.40±0.05^{af}	71.61±0.10^{bf}	71.99±0.11^{cf}	72.05±0.05^{df}
	T_3	74.23±0.06^{ag}	74.53±0.07^{bg}	75.08±0.18^{cg}	75.27±0.07^{dg}
	T_4	71.69±0.09^{ah}	71.94±0.07^{bh}	72.38±0.14^{ch}	72.53±0.06^{dh}
	T_5	58.21±0.10^{ai}	58.40±0.06^{bi}	58.80±0.10^{ci}	58.98±0.08^{di}

All the mentioned results are mean ± standard deviation of triplicate observations; Letters in superscript denote the significant and non-significant changes between blends and storage intervals; Horizontal letter grouping indicates significant changes during storage intervals; vertical letter grouping indicates significant changes between various blends (T1 to T5)

ments, with the lowest moisture value reported 6.91±0.02 for T_4 and the highest value of 8.09±0.04 for T_5 at fresh. The increasing moisture with shelf life might be attributed to the hygroscopic nature of samples leading to water absorption from surroundings over time. Variation in relative humidity during storage intervals might also be a reason for the elevated moisture in samples. The similar increase in moisture of samples over time were observed by Rehman *et al*., 2017 with moisture values increasing from 11.33% to 12.24% over a period of 45 days. Akbar and Ayub (2018) in a 3-month storage study of wheat and maize cookies, also observed an increase in moisture from 3.22 to 3.31%. Kumar *et al*. (2016) also recorded similar results for treatments of multigrain flour biscuits with values ranging from 3.19±0.06 to 3.60±0.08, 3.81±0.65 to 4.29±0.07, 4.51±0.08 to 4.95±0.06 for S_1, S_2, and S_3 treatment respectively. Further, in a storage study of tomato powder for 6 weeks by Oladipupo *et al*. (2020), the moisture content showed a similar trend of increase from 12.5 to 12.8%.

Ash (%)

Ash (%) content did not show any significant ($p \leq 0.05$) increase or decrease with an increase in storage interval. Therefore, the ash content remained unaffected in all the treatments T_1, T_2, T_3, T_4, and T_5 over the 3, 6 and 9 months storage interval. For blending with gram and rice flour, the variations in ash content were observed, with the highest ash content in blend T_5 (3.10±0.01) and the lowest ash content in blend T_3 (2.14±0.01). This might be because ash content is the amount of non-volatile material of food, which usually either remains unaffected or does not undergo any changes during the storage period. Previous results by Rehman *et al*. (2017) supported the findings as a similar minimum non-significant change in value for ash content (0.983% to 0.973%) was observed in the study. Ash content of wheat and maize cookies remained unaffected with a non-significant decrease from 0.76 to 0.75 in a three-month storage study conducted by Akbar and Ayub, 2018. Walde *et al*. (2021) in their research study on developed multigrain chapati (wheat, bajra, and ragi) also observed a similar non-significant decrease in ash (%) content with values varying from 3.07±0.04 to 3.06±0.05, 2.98±0.05 to 2.97±0.04, 2.76±0.04 to 2.75±0.05, and 2.63±0.05 to 2.62±0.04 for WBc, WRc, WBrc, and WbRc treatments respectively over a storage study of 30 days.

Crude protein (%)

The content of protein (%) also decreased significantly with increasing storage intervals with values ranging from 13.64±0.04 to 12.63±0.03 for T_1, 14.21±0.04 to 13.11±0.08 for T_2, 8.52±0.04 to 7.59±0.05 for T_3, 14.90±0.04 to 13.75±0.08 for T_4, and 24.50±0.06 to 23.25±0.10 for T_5. Blending showed a significant increase in protein content for T_2, T_4, and T_5. However, the content of protein decreased significantly for blend T_3. The decrease in protein content over time might be attributed to increased moisture content in samples over storage. The moisture must have accelerated the proteolytic activity of enzymes, thereby accelerating protein degradation and reducing its overall amount. The results regarding the decrease in protein content during the storage period were supported by the findings of Rehman *et al*. (2017), with protein content decreasing from 13.68% to 13.43% over 45 days. A decrease in protein from 8.15 to 7.85% was also found by Akbar and Ayub, 2018 in a 3 months storage study of wheat and maize cookies. Kumar *et al*. (2016) also recorded a decrease in protein content of treatments S_1 (6.83±0.04 to 6.72±0.03), S_2 (6.94±0.03 to 6.78±0.03), and S_3 (7.08±0.03 to 6.99±0.02) of multigrain flour biscuit. Another storage study of tomato powder for 6 weeks revealed a similar protein content trend (13.3 to 12.5%) (Oladipupo *et al*.,2020). Similarly, a decrease in crude protein (%) content from 51.67 to 51.12 was observed by Aswathy *et al*. (2014) in their study on functional poultry meat finger sticks.

Crude fat (%)

Fat (%) content also showed a significant decrease in amount over a storage interval of nine months for all the blends; i.e., T_1 (3.14±0.02 to 1.50±0.02), T_2 (3.30±0.02 to 1.68±0.02), T_3 (2.88±0.02 to 1.97±0.05), T_4 (3.50±0.02 to 2.48±0.04), and T_5 (6.10±0.04 to 4.57±0.05). Blending also led to a significant increase in fat for T_2 (3.30±0.02), T_4 (3.50±0.02), and T_5 (6.10±0.04). However, a reduction in overall fat content was observed for blend T_3 (2.88±0.02). The decrease in the amount of fat over the storage intervals might be because of increased rancidity. Chemical reactions like fat oxidation and fat deterioration into free fatty acids and glycerol due to lipase activity in the presence of moisture and light might be crucial factors for present observations. The findings were similar to Rehman *et al*. (2017), who also reported a reduction in fat content from 2.678% to 2.6.6% with an increase in storage period from fresh to 45 days intervals of stored cereal-legumes blended flours. A decrease in crude fat was recorded by Akbar and Ayub, 2018 in a 3-month storage study of wheat and maize cookies from 24.16 to 24.02% . Kumar *et al*. (2016) also recorded a decrease in crude fat content from 25.44±0.05 to 24.20±0.04, 27.44±0.02 to 26.20±0.05, and 30.25±0.04 to 29.10±0.03 of multigrain flour biscuit's treatment S_1, S_2, and S_3 respectively Another storage study of tomato powder for 6 weeks also revealed a similar trend in fat content (3.00 to 2.10%) (Oladipupo *et al*., 2020).

Crude fiber (%)

Crude fiber (%) also significantly reduced for all the treatments. The increase in intervals of storage led to a reduction in crude fibre content from 2.87±0.02 to 2.30±0.03 for T_1, 2.50±0.02 to 2.15±0.13 for T_2, 2.44±0.02 to 2.15±0.02 for T_3, 2.04±0.02 to 1.61±0.02 for T_4, and 1.30±0.02 to 1.06±0.02 for T_5 after nine months. The content of crude fibre also decreased significantly with blending for all the samples, with the highest reported value of 2.87±0.02 for T_1 and lowest value of 1.30±0.02 for T_5. The gradual decrease in crude fiber over storage might be due to the activation of lipase enzyme in the storage condition of ambient temperature which caused loss of fibrous content over the storage period. The results concur with Khan *et al*., 2016, as a similar decrease in crude fibre content from 8.2% to nearly 4% was recorded in fermented soyabean for a storage interval of four months in their research study. Akbar and Ayub (2018) in a study of wheat and maize cookies, also observed a decrease in crude fibre from 6.44 to 6.41%. In another study on the multigrain porridge formulations, Hussain (2020) also observed a decrease in crude fibre (%).

Total carbohydrate (%)

Overall amount of carbohydrates (%) showed a significant elevation in the blends over a storage interval for three, six, and nine months. For the treatment T_1, the amount of carbohydrates increased from 71.16±0.06 to 72.30±0.07. For other blends, i.e., T_2, T_3, T_4 and T_5, similar observations were made with the content of carbohydrates increasing from 71.40±0.05 to 72.05±0.05, 74.23±0.06 to 75.27±0.07, 71.69±0.09 to 72.53±0.06, and 58.21±0.10 to 58.98±0.08 respectively. The blending also led to a significant increase of carbohydrates in blend T_2, T_3, and T_4. However, the blend T_5 showed a significant decrease. The highest reported carbohydrate content was in blend T_3 (74.23±0.06) and the lowest reported carbohydrate content was in blend T_5 (58.21±0.10). Sucrose being converted into reducing sugars might be responsible for the increasing carbohydrate content. The findings were in concurrence with the findings of Sharma *et al*., 2019 who also reported an increasing carbohydrate content in *boondi* prepared from blending of Bengal gram and rice bean flour from

49.70% to 53.58% for over a storage period of six months. Hussain (2020), in his experimental approach of developing a multigrain porridge from buckwheat, barley, and apricot powder observed similar observations of increase in carbohydrates (%) for the formulations i.e., F_1 (70.89 to 72.81), F_2 (67.16 to 69.03), F_3 (70.40 to 72.35), F_4 (69.54 to 71.44), F_5 (68.57 to 70.51), and F_6 (66.26 to 68.20) over a storage period of 150 days. He also discussed that the breakdown of complex polysaccharides into simple sugars must be the reason for this increase in carbohydrates over the storage period. Chukwu and Abdullahi (2015), in a study on cassava flours for storage interval pf 3 weeks, also observed an increase in carbohydrate content from 76.53±1.85 to 81.64± 0.05, 73.69± 0.20 to 85.20± 0.49, 72.14± 0.77 to 83.24± 0.29 for sample A, B, and C respectively. In another shelf-life study of 90 days on functional biscuits, a significant increase in carbohydrates (%) content was observed for all the treatments, i.e., T_1 (73.06 to 73.65), T_2 (70.79 to 71.38), T_3 (72.87 to 73.46), T_4 (72.94 to 73.53), T_5 (73.06 to 73.65), T_6 (73.19 to 73.78), T_7 (73.34 to 73.93), and T_8 (73.47 to 74.06) (Hussain *et al*., 2018). Overall, it can be said that a significant increase in moisture and carbohydrates was observed with storage interval. However, the protein, fat, and crude fibre content decreased for all the blends with increased storage intervals. However, the proximate composition, i.e., moisture, ash, protein, fat, crude fiber, and carbohydrates of all the treatments, varied for every blend. This might be due to variations in the nutrient composition of the composite flour used for the development of different blends of *chilla* mix. For instance, the barley flour, rice flour, and gram flour used for the development of various blends had varying proximate compositions of nutrients. Therefore, increasing and reducing the amount of different flours in different treatments led to variations in their proximate composition.

Sensory evaluation

The mean values of sensory scoring (Fig. 2) varied for all the treatments in terms of color, texture, taste, flavor, and overall acceptability. Storage interval also significantly affected sensory scoring as the scoring on 9-point hedonic scale decreased significantly with increasing time interval of storage for all the blends. The mean score for color, texture, taste, flavor, and overall acceptability decreased from 7±0.05 to 5±0.02, 7±0.02 to 6±0.02, 7±0.02 to 5.5±0.02, 7±0.12 to 5±0.13, and 7±0.50 to 5.25±0.03 for T_1. For T_2, i.e., the treatment with BF:RF:GF as 70:15:15 also showed a significant decrease in color (9±0.05 to 7±0.02), taste (8±0.05 to 7±0.02), flavour (9±0.05 to 8±0.02), and overall acceptability (8.5±0.05 to 7.5±0.02). However, the texture (8±0.05) did not significantly change with increasing storage interval for the prepared T_2 instant *chilla* mix. Organoleptic evaluation for T_3 also showed a significant decrease with values decreasing from 8±0.05 to 7±0.02 for color, 7±0.05 to 6±0.02 for texture, 8±0.05 to 6±0.02 for taste, 9±0.05 to 8±0.02 for flavor, and 8±0.05 to 6.75±0.02 for overall acceptability.T_4 also showed a similar trend of decrease in sensory scoring with values

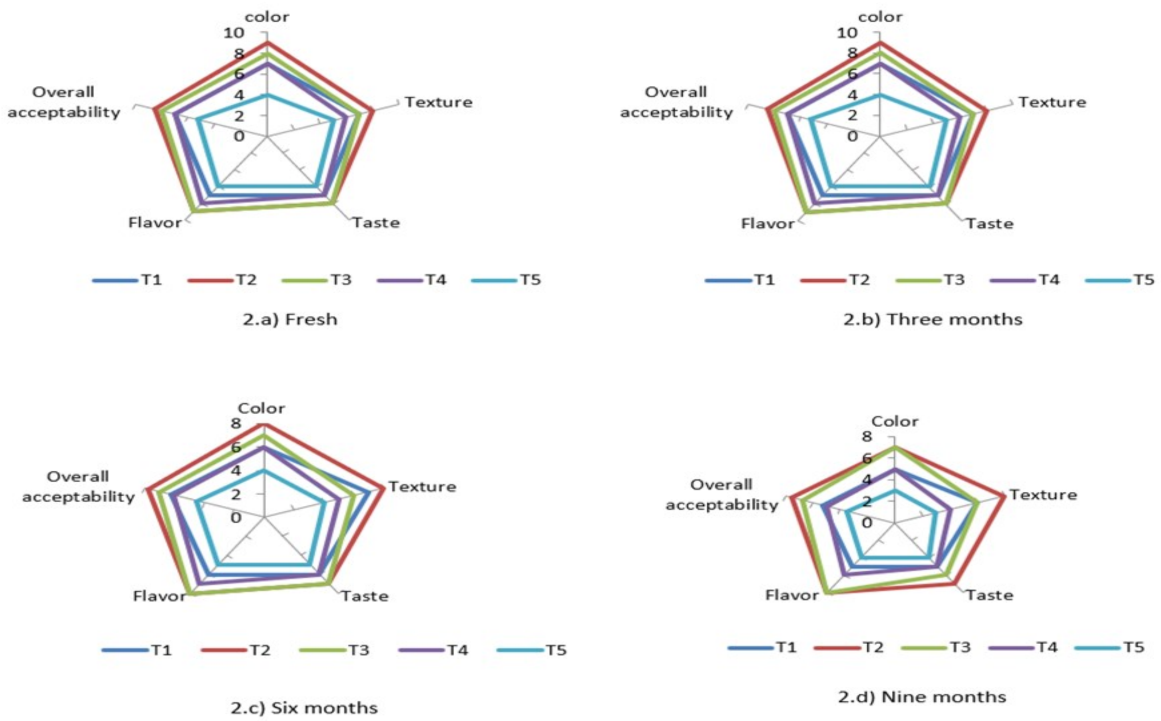

Fig. 2. *Comparison of different characteristics of sensory evaluation of chilla mix (a) fresh, (b) 3 months of storage period, (c) 6 months of storage period, and (d) 9 months of storage period*

ranging from 7±0.05 to 5±0.02, 6±0.05 to 4±0.02, 7±0.05 to 5±0.02, 8±0.05 to 6±0.02, and 7±0.05 to 5±0.02 for color, texture, taste, flavor, and overall acceptability respectively. The blend T_5 with 100% composition of gram flour also showed a similar significant decrease in sensory scoring over the storage interval of 9 months for color (4±0.05 to 3±0.02), texture (5±0.05 to 3±0.02), taste (6±0.05 to 4±0.02), flavor (6±0.05 to 4±0.02), and overall acceptability (5.25±0.05 to 3.5±0.02).

The study concluded that the blend T_2 with 70% barley flour was most acceptable at all the storage intervals in terms of sensory scoring at 9-point hedonic scale for all the sensory attributes, with its overall acceptability as 8.5±0.05 for fresh, 8.0±0.34 for three months of storage interval, 7.75±0.05 for six months of storage interval, and 7.5±0.05 for nine months of storage interval. The overall acceptability of T_2 varied from liked extremely to liked moderately. The organoleptic scoring for T_3 was second highest, followed by T_1, T_4, and T_5. Degradation of volatile flavoring might have affected the taste and flavor (Banyal *et al*., 2022). A similar decrease in sensory attributes was observed in developed barley chips over a storage period of 180 days (Prakash *et al*., 2015).

Conclusion

The present investigation revealed that barley flour is a good nutritional substitute for developing food products. Also, the developed instant *chilla* mix might be an organoleptically acceptable convenience food product with an efficient shelf life (9 months). The developed product will also turn out to be a good substitute for roti/ tortilla, which takes a good amount of time for processes such as dough making. The results also revealed that it was rich in protein (7.59 to 24.50%), ash (2.11 to 3.10%), fat (1.50 to 6.10%), carbohydrates (58.21 to 75.27%), and crude fiber (1.08 to 2.87%). The mentioned nutritional parameters were affected significantly ($p \leq 0.05$) by storage interval. The sensory scoring for organoleptic attributes also decreased slightly over the storage period of nine months. The treatment T_2 was most acceptable in sensory scoring among all the blends. This treatment also exhibited a rich nutrient profile, making it the most suitable blend of all the prepared treatments.

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Conflict of Interest

The authors declare that they have no conflict of interest.

REFERENCES

1. Akbar, K. & Ayub, M. (2018). Effect of storage on the quality of wheat and maize based cookies. *Sarhad Journal of Agriculture*,34(3), 606-615. http://dx.doi.org/10.17582/journal.sja/2018/34.3.606.615
2. Aludatt, M. H., Ereifej, K.& Abu-Zaiton, A. (2012). Antioxidant, anti-diabetic, and anti-hypertensive effects of extracted phenolics and hydrolyzed peptides from barley protein fractions.*International Journal of Food Properties*, 15(4), 781-795. DOI: 10.1080/10942912.2010.503357
3. AOAC (2000) Official Methods of Analysis. 17th Edition, The association of official analytical chemists, Gaithersburg, MD, USA. Methods 925.10, 65.17, 974.24, 992.16
4. Aswathy, P. B., Biswas, A. K,,Beura, C. K. & Yadav, A. S. (2014). The effect of storage period on proximate composition and sensory characteristics of functional poultry meat finger sticks.*Indian Journal of Poultry Science*, 49 (2), 190-192.
5. Chukwu, O. & Abdullahi, H. (2015). Effects of moisture content and storage period on proximate composition, microbial counts and total carotenoids of cassava flour. *International Journal of Innovative Science, Engineering & Technology*, 2(11), 753-763.
6. Deepika., Kumari, A., Prajapati, P., Sarita., Kumar, S., Aluko, R.E., Singh, S.& Garg, M. (2023).Pharmacological and therapeutic potential of *Cucumis callosus*: a novel nutritional powerhouse for the management of non-communicable diseases. *Plant Foods for Human Nutrition*, 78(4), 630-642. https://doi.org/10.1007/s11130-023-01098-y
7. Deepika., Sarita. & Kumari, A. (2023). Nutritional, shelf-life, and sensory evaluation of *Cucumis callosus* based optimized syrup. *Plant Foods for Human Nutrition*, 1-9..https://doi.org/10.1007/s11130-023-01124-z
8. Hussain, A. (2020). Characterization and storage studies of instant multigrain porridge made from underutilized crops of Ladakh. . *International Journal of Food and Fermentation Technology*, 10(2), 119-127. DOI: 10.30954/2277-9396.02.2020.8
9. Hussain, A., Kaul, R. & Bhat, A. (2018). Development and evaluation of functional biscuits from under utilized crops of Ladakh. *International Journal of Current Microbiology and Applied Sciences*, 7(3), 2241-2251. DOI:10.20546/ijcmas.2018.703.264
10. Ikegami, S., Tomita, M., Honda, S., Yamaguchi, M., Mizukawa, R., Suzuki, Y., Ishii, K., Ohsawa, S., Kiyooka, N., Higuchi, M. & Kobayashi, S. (1996). Effect of boiled barley-rice-feeding in hypercholesterolemic and normolipemic subjects. *Plant foods for humannutrition*, 49, 317-328. https://doi.org/10.1007/BF01091981
11. Khan, M. A., Bala, L.& Husain, S. A. (2016).To study the effect of drying methods on physic-chemical characteristics of fermented soybean (hawaijar). *International Journal of Scientific Research in Science, Engineering and*

Technology, 2(4), 840-845.

12. Kumar, R., Shamsher. & Chandra, S. (2016).Studies on proximate analysis of biscuits using multigrain flours during ambient condition. *International Journal of Food Science and Nutrition* ,1(2), 39-41.
13. Lahouar, L., Ghrairi, F., El Arem, A., Medimagh, S., El Felah, M., Salem, H.B. & Achour, L. (2017). Biochemical composition and nutritional evaluation of barley rihane (Hordeum vulgare L.). *African Journal of Traditional, Complementary and Alternative Medicines*, 14(1), 310-317.https://doi.org/10.21010/ajtcam.v14i1.33
14. Larmond, E. (1977). Laboratory methods for sensory evaluation of foods. Canada Department of Agriculture Publication No. 1637. *Food Research Institute Ottawa*,73
15. Lee, S.Y., Kim, T.Y., Hong, J.Y., Kim, G.J., Oh, J.B., Kim, M.J., Apostolidis, E., Lee, J.Y. &Kwon, Y.I. (2022). Anti-obesity and anti-adipogenic effects of administration of arginyl-fructose-enriched jeju barley (*Hordeum vulgare L.*) Extract in C57BL/6 mice and in 3T3-L1 preadipocytes models. *Molecules,* 27(10), 3248. https://doi.org/10.3390/molecules27103248
16. Oladipupo, R., Yusuf, K.A. & Salawu, G. (2020) Effect of storage materials on the proximate composition of tomato (Lycopersicon esculentum) powder. *Fudma Journal of Sciences,* 4(2), 203-206. https://doi.org/10.33003/fjs-2020-0402-212
17. Prakash, J., Naik, H.R., Hussain, S.Z.& Singh, B. (2015).Effect of processing conditions on the quality characteristics of barley chips. *Journal Of Food Science and Technology*, 52(1), 294–302. https://doi.org/10.1007/s13197-013-0997-8
18. Rani, A., Sood, S. & Bhat, F.M. (2020).Physico-chemical and functional properties of three hull-less barley (*Hordeum vulgare*) varieties grown in the high altitude region. *International Journal of Current Microbiology and Applied Sciences,*9(9), 2069-2077. DOI: 10.20546/ijcmas.2020.909.258
19. Rehman, T., Mian Kamran, S., Majeed, M., Khan, M.U., Shariati, M.A. &Karapetkovska-Hristova, V. (2017). Effect of nutritional composition on shelf life of cereals-legumes blended flours during storage. *Journal of Microbiology, Biotechnology and Food Sciences* , 6(4), 1112-1116. DOI: 10.15414/jmbfs.2017.6.4.1112-1116
20. Rendell, M., Vanderhoof, J., Venn, M., Shehan, M.A., Arndt, E., Rao, C.S., Gill, G., Newman, R.K. & Newman, C.W. (2005).Effect of a barley breakfast cereal on blood glucose and insulin response in normal and diabetic patients. *Plant Foods for Humun Nutrition*,60(2), 63–67. https://doi.org/10.1007/s11130-005-5101-8
21. Sharma, S., Dhaliwal, Y.S. & Verma, R. (2019). Nutritional quality evaluation of rice bean flour based boondi. *Journal of Pharmacognosy and Phytochemistry*, 8(1), 93-97.
22. Banyal, S., Kumari, A., Sharma, S.P. & Dhaliwal, Y.S. (2022). Effect of varieties and storage on the quality parameters of nectarine (*Prunus persica*)-based intermediate moisture food (IMF) products. *Journal of Applied and Natural Science*, 14(1), 216-224. https://doi.org/10.31018/jans.v14i1.3299
23. Sonkar, S., Saha, T.S. & Singh, A. (2015). Development and standardization of soup mix based on black rice and okra powder value added with barley. *Plant Archives*, 15 (2), 909-911.
24. Sundberg, B., Abrahamsson, L. & Åman, P. (1994). Quality of rolled barley flakes as affected by batch of grain and processing technique. *Plant Foods for Human. Nutrition*,45(2), 145–154. https://doi.org/10.1007/BF01088472
25. Tok, K., Moulahoum, H., KocadagKocazorbaz, E. &Zihnioglu, F. (2021). Bioactive peptides with multiple activities extracted from barley (*Hordeum vulgare L.*) Grain protein hydrolysates: Biochemical analysis and computational identification. *Journal of Food Processing and Preservation*, 45(1), e15024. Doi:10.1111/jfpp.15024
26. Walde, S.G., Agrawal, S. & Mittal, S. (2021). Development of multigrain chapatti with spices mix to enhance the nutritional values and their storage study. *Journal of Food Science and Technology* ,58(3), 1132–1142. https://doi.org/10.1007/s13197-020-04627-8