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DEVELOPMENT OF FUNCTIONAL BULGAR USING PAKISTANI WHEAT VARIETIES AND CHARACTERIZATION WITH RESPECT TO PHYTOCHEMICAL AND ORGANOLEPTIC PROPERTIES

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Abstract

To screen out the potential cultivars through various parameters for their bulgur making suitability, the experiment was performed in NIFSAT, UAF in which characterization of wheat samples including (Durum-97, Punjab-11, Fakhar-e-Bhakkar 16, Anaj-17, Barani-17, Nifalama-KPK) were selected. Verities assessed in thousand kernel weight, test weight, grain length, width and thickness. Compositional analysis of wheat showed differences among the cultivars for moisture, ash, crude protein, crude fat, crude fiber, NFE, Ca, Fe, Zn, Na and K. Based on compositional and grain characterization Fakhar-e-Bhakkar 16 was selected for the preparation of functional bulgur. Results indicated that phytochemical and organoleptic properties of functional bulgar showed the significant effect ($p<0.05$) among the treatments.

Keywords: Wheat Characterization, Bulgur Production, Grain Properties, Nutritional Analysis.

1. INTRODUCTION

Cereal grains play vital role in retaining and promoting human nutrition. Cereal crops being a dietary staple are the main source of nutrients and calories for humans. In Pakistan, nearly 80% of the grain consumption is in form of *rotis*, *chapatis* and *naan* [1]. According to agronomic and end-user traits such as growth pattern, grain color and hardness, wheat can be categorized into hard and soft wheat, both types are unique in end-use quality [2]. The hardness of wheat is commonly associated with high protein levels and its complex bonding with starch. Moreover, there will be more damaged starch in the resultant Flour [3].

Food's functional properties can be characterized by various parameters like the quality, nutritional value, structure, texture, appearance and acceptability of products. Functional properties also explain the behavior of food ingredients during preparation, cooking as well as final consumption affecting the appearance and taste of finished food products. Functional characteristics also help to predict and precisely evaluate the behavior of fats, proteins, and carbohydrates (sugar and starches). Legumes are considered a valuable

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source of proteins, carbohydrates, dietary fiber, vitamins and minerals [4]. These belong to the family *Leguminosae* which is also known as *Fabaceae*. It is advisable to consume legumes and cereals together as these complement each other. Lysine, an essential amino acid, is deficient in cereals whereas it is abundantly present in legumes. The blends of cereals and legumes can complement each other and may be helpful in eradication of the protein malnutrition especially in low-income countries. Additionally, legumes are also getting popularity due to functional properties and numerous health benefits conferred by their phytochemicals [5].

Among the legumes, soybean has gained paramount importance as its protein has all the essential amino acids required for human growth and development. Likewise, green pea is another important crop in developing countries. It grows comparatively in short time and provide quality protein. Chickpea is also a popular legume with suitable amounts of protein and low anti-nutritional factors [6].

Realizing the importance of whole kernels in balanced diet as well as the global approaches for healthy diets, the present project has been designed to screen out commercially cultivated Pakistani wheat varieties for the preparation of whole grain product “functional bulgur” for diet diversification as well as value-addition. The objectives of the present study were development of functional bulgar from different Pakistani wheat verities and its phytochemical and sensorial characterization.

2. MATERIALS AND METHODS

2.1. Procurement and Preparation of Raw Materials

Commercial Pakistani wheat varieties were procured from Ayub Agriculture Research Institute (AARI) Faisalabad, Punjab (Durum-97, Punjab-11, Fakhr-e-Bhakkar 16, Anaj-17, Barani-17,) and from Cereal Crop Research Institute, KPK (Nifalalma-KPK). All samples were physically cleaned by removing foreign particles including dirt, straws, stones and deformed kernels. A part of samples was milled into fine flour using Lab Mill (Laboratory Mill 3100, Perten Instruments AB, Huddinge, Sweden) and stored in air tight containers for further analysis.

2.2. Characterization of Wheat Samples

All samples of wheat were assessed for thousand kernel weight, test weight and proximate composition by using the following methods: Thousand kernal weight (g) of wheat samples was measured by counting 1000 grains in numerical grain counter followed by weighing on electric balance. Test weight was estimated by using bushel equipment having a filling hopper to standardize the pouring rate and a striker to level the contents of the container through AACC Method No. 55-10.01. The length, size and width of the randomly selected 100 wheat kernels were measured using a micrometer (vernier caliper). All wheat flour samples were subjected to proximate analysis according to the AOAC, 2018 as mentioned in literature [7]. Moisture contents was determined using hot air oven after 24 hours placing the sample. Crude fat of moisture free sample was measured through soxhelt apparatus using n-hexane. Similarly, crude fiber was

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determined by Labconco Fibertech. Protein contents was measured using Kjeldhal method. Likewise, ash contents were estimated by the muffle furnace at 550℃ for 5-6 hours. The NFE (Nitrogen free extract) was calculated by the difference method.

2.3. Color and texture analysis

Color analysis of bulgur was determined according to the described methods with slight modifications [7] using the CIE-lab SPACE, (Color Tec-PCM, NY, USA). The L*, a*, and b* were measured at different parts of the sample in triplicates. Similarly, texture of bulgar were calculated according to the suggested methods [8] using a Texture analyzer (TA-XT Plus, Stable Microsystem, UK) equipped with a 50.00 kg load cell and operating with Exponent 6.1.4.0 software (Stable Micro Systems, Surrey, UK). In this method, sample was horizontally placed and compression force was applied with the help of load cell. Textural properties of bulgur like hardness (g), cohesiveness, chewiness, adhesiveness, and springiness were measured by using Texture Analyzer.

2.4 Selection of Best Wheat for Preparation of Functional Bulgur

Based on the grain characterization, proximate composition, color, and textural attributes, Fakhar-e-Bhakkar 16 was selected for further use in the study.

2.5 Preparation of Functional Bulgur

The nutritional quality and palatability of the Fakhar-e-Bhakkar 16 was improved by blending with soybean (10%) and different levels of chickpea and peas. Wheat grains (500g) were soaked overnight in water afterwards, wheat kernels were solar-dried to achieve a moisture content of ~13%. The parboiling of wheat was carried out at 97ºC for one hours, followed by drying using solar drier. After that, milling process done to obtained the coarse particle and functional bulgar was prepared using the given treatment plan.

Table 1: Preparation of functional bulgar from wheat varieties

Treatments	Wheat Bulgur (%)	Legumes (%)		
		Soybean	Chickpea	Pea
WB_{100}	100	-	-	-
WB_{90}-S_{10}	90	10	-	-
WB_{85}-S_{10}-C_{5}	85	10	5	-
WB_{80}-S_{10}-C_{10}	80	10	10	-
WB_{75}-S_{10}-C_{15}	75	10	15	-
WB_{70}-S_{10}-C_{20}	70	10	20	-
WB_{85}-S_{10}-P_{5}	85	10	-	5
WB_{80}-S_{10}-P_{10}	80	10	-	10
WB_{75}-S_{10}-P_{15}	75	10	-	15
WB_{70}-S_{10}-P_{20}	70	10	-	20
WB_{85}-S_{10}-$C_{2.5}$-$P_{2.5}$	85	10	2.5	2.5
WB_{80}-S_{10}-C_{5}-P_{5}	80	10	5	5
WB_{75}-S_{10}-$C_{7.5}$-$P_{7.5}$	75	10	7.5	7.5
WB_{70}-S_{10}-C_{10}-P_{10}	70	10	10	10

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WB_{100} (Bulgur without legumes) and WB_{90}-S_{10} (Bulgur with 10% soybean) acts as control

2.6 Phytochemical characterization of Functional Bulgur

2.6.1 Extract preparation

Extracts for total phenolic contents, total flavonoid contents and antioxidant activity were prepared at room temperature (25℃) by mixing functional bulgar with 80% methanol (2 mL) for 2h using an orbital shaker at 200 rpm and centrifuged at 7000 rpm for 10 mints. Supernatants were collected and centrifuged through Whatman Filter No. 2 to remove insoluble particles

2.6.2 Total phenolic content

Bulgur treatments were analyzed for total phenolic content by using spectrophotometer (VIS-1100, Biotechnology Medical Services, Quebec, Canada). The extract was mixed with Folin-Ciocalteau reagent (125µL) along with 500µL distilled water. Then the mixture was allowed to stand at 22^{o}C for 5min. After some time, 4.5mL of sodium bicarbonate solution was added to the mixture. After 1.5hrs, absorbance of the sample was measured at 765nm using a UV/VIS Spectrophotometer against control. Total phenolic contents were calculated and expressed as Gallic acid Equivalent (mg gallic acid/g).

2.6.3 DPPH free radical scavenging ability

Free radical scavenging activity was determined using the methodology of [10] with few modifications. Firstly, 1mL sample solution, standard (ethanol/n-hexane 1+1, v/v) and 0.5mL of 0.3M methanolic 1,1-diphenyl-picrylhydrazyl (DPPH) solution in falcon tubes was taken followed by shaking (25±1°C, 1000x*g*) in a thermo-shaker (D-79219, IKA-Werke GmbH & Co., Staufen, Germany). After 15mins, the absorbance of samples and standards was taken using a spectrophotometer at 540nm and inhibition was calculated using the following formula:

$$DPPH = 1 - \frac{A_f}{A_0} \times 100$$

where, A_0 and A_f are absorbance values of the blank (DPPH solution with no bulgar added) and bulgar samples, respectively.

2.6.4 ABTS radical scavenging activity

ABTS (2, 2-Azino-Bis-3-Ethylbenzothiozaline-6-Sulfonic Acid) stock solution was diluted in 50 mM di-potassium phosphate buffer (pH 8.0). One milliliter of that solution was mixed with 100mL of sample extract or blank solution. After waiting for exactly 40s, the absorbance of the solution was determined at 734nm. Trolox was used as a standard, and results were given as antioxidant capacity for mmol of Trolox Equivalent Antioxidant Capacity (TEAC) in 100g dry matter [9].

2.7 Organoleptic properties

The functional bulgar were evaluated for organoleptic properties (color, taste, texture, mouthfeel and overall acceptance) by semi-trained panelists at National Institute of Food

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Science and Technology, University of Agriculture, Faisalabad. The panelists comprised of 30 members of faculty and postgraduate students. An unbiased assessment was conducted using a 9-point hedonic scale to evaluate the organoleptic properties of functional bulgar. The sample were labelled with codes and presented in separate booths equipped with white fluorescent light. Consequently, the actual composition of functional bulgar was not disclosed to the panelists for their impartial judgment about each sample. The functional bulgar were offered to panelists on coded plates at room temperature (25℃). Plain water was provided to panelists before each evaluation to rinse their mouths and neutralize their taste buds [10, 11].

2.8 Statistical analysis

All the experiments were performed in triplicates and statistical analysis was carried out using complete randomized design followed by Tukey test at 5% level of significance. The results are presented as mean values along standard deviation. Various letters indicate significant ($p<0.05$) difference among the treatments.

3. RESULT AND DISCUSSION

3.1 Characterization of Wheat Samples

Characterization of wheat grains sample was presented in Table 2. Results showed that thousand kernal weight of various wheat varieties showed significant effect ($p<0.05$). The maximum thousand kernal weight was observed in Durum-97 (47.50g) and minimum thousand kernal weight was noted in Anaj (43.55g). It may be attributed that the variations in thousand kernel weight are due to differences in genetic make-up of different cultivars along with environmental factors and agronomic practices [1]. Similarly, test weight of different wheat verities also showed the significant difference among the treatments. The highest test weight was noticed in Anaj-17 and lowest test weight was measured in Barani-17. The difference in test weight is due to the genetic variation along climatic conditions prevailing during the crop growth khan [12].

The highest length was observed in Durum-97 (7.36 mm) and lowest in Punjab-11 (6.33mm). In grain width, the highest value was noticed in Fakhar-e-Bhakkar-16 (3.66mm) and minimum width was observed in Anaj-17 (3.05mm). Likewise, the maximum thickness in wheat grain was measured in Durum-97 (3.86mm) and minimum thickness was observed in Nifalama-KPK (2.84mm). The variation in wheat grain characterization (length, width and thickness) is affected due to the wheat cultivars. However, grain length, width and thickness of dry land contained longer and thinner as compared to heavy irrigated land [13, 14].

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Table 2: Grain characterization of different wheat varieties

Varieties	Thousand kernal weight (g)	Test weight (g)	Grain (mm)		
			Length	Width	Thickness
Durum-97	47.50±1.15[a]	79.20±0.91[a]	7.36±2.7[a]	3.48±0.25[a]	3.86±0.10[a]
Punjab-11	44.49±0.31[ab]	74.60±0.81[bc]	6.33±2.30[de]	3.32±0.17[cd]	3.07±0.10[bcd]
Fakhar Bakhar-16	45.21±0.23[ab]	76.40±0.72[ab]	7.20±2.61[ab]	3.66±0.14[a]	3.32±0.44[abc]
Barani-17	44.05±0.48[bc]	74.24±0.98[bc]	6.74±1.84[c]	3.29±0.14[def]	2.92±0.16[bcd]
Anaj-17	43.55±1.05[bc]	81.62±0.70[ab]	6.47±1.40[d]	3.05±0.07[gh]	3.06±0.21[bcd]
Niflama-KPK	44.86±1.35[ab]	76.36±0.70[ab]	7.29±2.78[ab]	3.53±0.14[ab]	2.84±0.11[bcd]

3.3 Mineral analysis

The mineral composition of different wheat verities as shown in Table 3. Results indicated that various wheat verities had a significant effect ($p<0.05$) on the mineral composition. Calcium contents in wheat verities were in the range of 368.30 to 535.33mg/Kg. Similarly, the maximum iron contents in wheat verities were present in Durum-97 (50.18mg/Kg) and minimum iron contents was observed in Niflama-KPK (36.32±3.21mg/Kg). Likewise, the highest sodium contents in wheat verities observed in Barani (320mg/Kg) and lowest sodium contents was noticed in Punjab-11 (173.47mg/Kg). The maximum potassium contents in wheat verities were measured in Anaj-17 (945mg/Kg) and minimum potassium content was observed in Niflama-KPK (791±44.55mg/Kg). The variation in mineral composition of wheat cultivar is due to the genetic variations and environment conditions [15].

Table 3: Mineral composition (mg/kg) of different wheat varieties

Verities	Ca	Fe	Zn	Na	K
Durum-97	535.33±33.51[a]	50.18±1.53[a]	20.67±1.76[a]	209.53±5.81[a]	814±45.02[a]
Punjab-11	368.30±28.51[b]	46.40±1.93[bc]	17.63±0.74[a]	173.47±4.70[b]	854±48.94[c]
Fakhar Bakhar-16	480.60±33.3[c]	44.41±1.06[cde]	23.46±1.08[cd]	316.00±4.57[d]	861±44.04[e]
Barani-17	381.37±29.0[d]	42.37±1.07[def]	22.22±1.09[de]	320.10±3.67[e]	880±45.87[e]
Anaj-17	535.60±34.51[e]	41.11±1.53[ef]	22.10±1.76[de]	271.33±3.81[f]	954±55.02[f]
Niflama-KPK	427.33±31.02[g]	36.32±3.21[gh]	24.96±1.62[fg]	211±2.7[gh]	791±44.55[s]

3.4 Color and texture analysis

Color of different wheat verities was measured and results are presented in Table 4. Results indicated that various wheat verities had a significant effect ($p<0.05$) on the color analysis (L, a, b values). L values indicate the darkness or brightness of the sample. The highest value was in Durum-97 (58.60) followed by Fakhar-e-Bakhar-16 (57.37) whereas the lowest L value was observed in Nifalama-KPK (54.68±2.08) and Punjab-11 (56.94±2.12). The b value was in the ranged from -1.03 to 3.02. Similarly, b value was ranged from 17.22 to 21.91. The maximum value was in Fakhar-e-Bhakkar 16 (21.91) and lowest in Anaj-17 (17.22). The differences in color values in different varieties is might be due to variation in processing methods [16]. Texture of wheat verities was determined and results are presented in Table 4. Results indicated that all parameters of texture showed a significant effect ($p<0.05$). The maximum hardness was observed in Fakhar-e-Bhakkar 16 (3993g) and minimum hardness was measured in Anaj-17 (621g). The

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variation in hardness is due to genetically variation which caused the hardness level of wheat varieties. Similarly, the maximum cohesiveness in wheat verities was observed in Niflama-KPK (0.73) and minimum cohesiveness was noticed in Punjab-11 (0.68). Likewise, adhesiveness was in the range of -7.07 to -9.26. The springiness value of wheat verities was in the ranging from 0.62 to 0.73. The maximum springiness value was observed in Niflama-KPK and minimum was noticed in Anaj-17.

Table 4: Color analysis and textural properties of different wheat verities

Verities	Color Value			Texture			
	L	a	b	Hardness (g)	Cohesiveness [18]	Adhesiveness (g x sec)	Springiness
Durum-97	58.60±2.30[b]	-1.98±0.02[c]	20.54±1.03[c]	1676±13.5[a]	0.69±0.05	-9.26±0.32[a]	0.69±0.05[bc]
Punjab-11	56.94±2.12[d]	-2.98±0.08[e]	21.06±1.19[b]	1535±17.0[ab]	0.68±0.01	-7.07±0.15[c]	0.63±0.10[c]
Fakhar Bakhar-16	57.37±3.41[c]	-1.44±0.09[b]	21.91±2.07[a]	3993±44.5[f]	0.72±0.02	-8.13±0.67[b]	0.78±0.12[a]
Barani-17	57.04±1.14[cd]	-1.13±0.02[a]	18.23±1.75[d]	734±8.90[d]	0.71±0.08	-7.13±0.35[c]	0.72±0.61[ab]
Anaj-17	56.28±1.68[e]	-2.40±0.07[d]	17.22±1.09[f]	621±6.6[e]	0.70±0.03	-9.02±0.49[a]	0.62±0.43[c]
Niflama-KPK	54.68±2.08[a]	-3.02±0.15[e]	17.76±0.23[e]	3355±20.5[c]	0.73±0.01	-7.68±0.76[c]	0.73±0.31[ab]

3.5 Phytochemical characterization of functional bulgar

3.5.1 Total phenolic contents

The total phenolic contents (TPC) in functional bulgur were determined and results are presented in Table 5. Results revealed that TPC of functional bulgar had a significant effect ($p<0.05$) among the formulations. The highest TPC was observed WB_{70}-S_{10}-C_{20} (1.00±0.08mgGAE/g**)** and the lowest TPC was presented in WB_{100} (0.62±0.04mgGAE/g). The TPC was increased with the addition of soy along 20% chickpea. The increase in TPC is might be due to the blending of bulgar with legumes. Other reason of TPC variation is due to the milling, processing, cooking methods and its cooking temperature, and milling methods as well as branning in milling stage of bulgur production. Hence, the functional properties of conventional bulgur were improved by the addition of soy, chickpea and peas.

3.5.2 Antioxidant potential through ABTS and DPPH

The antioxidant potential of functional bulgar was measured and results are depicted in Table 5. Results showed that DPPH and ABTS of functional bulgar had a significant effect ($p<0.05$) among the formulations. The minimum ABTS (5.24±0.34µmol TEAC/g) was observed in WB_{70}-S_{10}-P_{20} and the highest ABTS (6.19µmol TEAC/g) was observed in WB_{90}-S_{10}. The maximum ABTS for blend of bulger-soy with chickpea and pea was in WB_{85}-S_{10}-C_5 (5.94µmol TEAC/g) and WB_{85}-S_{10}-P_5 (5.98µmol TEAC/g) while minimum was noted in WB_{70}-S_{10}-C_{20} (5.31µmol TEAC/g) and WB_{70}-S_{10}-P_{20} (5.24±0.34µmol TEAC/g), respectively. The ABTS value in blends containing both chickpeas showed the maximum value (5.95±0.80µmol TEAC/g) observed in WB_{85}-S_{10}-$C_{2.5}$-$P_{2.5}$ whereas lowest value (5.27±0.37µmol TEAC/g) showed by WB_{70}-S_{10}-C_{10}-P_{10}. The maximum DPPH (43.61±1.60µgTEAC/g) was measured in WB_{90}-S_{10} while the lowest (22.50±1.02µgTEAC/g) was in WB100. For the blends of bulgur-soy with chickpea and

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pea, values that the maximum value (63.25µgTEAC/g) was found in WB_{70}-S_{10}-C_{20} whereas the lowest (46.0µgTEAC/g) in WB_{85}-S_{10}-P_{5}. The DPPH of blends containing both chickpea and pea that the highest value (57.73µgTEAC/g) was measured in WB_{70}-S_{10}-C_{10}-P_{10} whereas minimum (47.40µgTEAC/g) was in WB_{85}-S_{10}-$C_{2.5}$-$P_{2.5}$.

Table 5: Phytochemical characterization of functional bulgar

Treatments	ABTS (µmol TEAC/g)	DPPH (µgTEAC/g)	TPC (mgGAE/g)
WB_{100}	$5.99±0.76^{ab}$	$22.50±1.02^{i}$	$0.62±0.04^{b}$
WB_{90}-S_{10}	$6.19±0.81^{a}$	$43.61±1.6^{h}$	$0.77±0.02^{ab}$
WB_{85}-S_{10}-C_{5}	$5.94±0.56^{ab}$	$48.78±2.2^{e\text{-}g}$	$0.80±0.06^{ab}$
WB_{80}-S_{10}-C_{10}	$5.75±0.29^{ab}$	$53.60±1.9^{cd}$	$0.85±0.03^{ab}$
WB_{75}-S_{10}-C_{15}	$5.53±0.61^{ab}$	$58.43±2.6^{b}$	$0.95±0.05^{ab}$
WB_{70}-S_{10}-C_{20}	$5.31±0.47^{ab}$	$63.25±2.3^{a}$	$1.00±0.08^{b}$
WB_{85}-S_{10}-P_{5}	$5.98±0.23^{ab}$	$46.00±1.7^{gh}$	$0.81±0.04^{ab}$
WB_{80}-S_{10}-P_{10}	$5.71±0.71^{ab}$	$48.02±1.5^{e\text{-}g}$	$0.79±0.06^{ab}$
WB_{75}-S_{10}-P_{15}	$5.48±0.76^{ab}$	$50.15±2.01^{d\text{-}g}$	$0.83±0.05^{ab}$
WB_{70}-S_{10}-P_{20}	$5.24±0.34^{b}$	$52.20±2.3^{de}$	$0.86±0.07^{ab}$
WB_{85}-S_{10}-$C_{2.5}$-$P_{2.5}$	$5.95±0.80^{ab}$	$47.40±1.6^{f\text{-}h}$	$0.82±0.03^{ab}$
WB_{80}-S_{10}-C_{5}-P_{5}	$5.73±0.41^{ab}$	$50.84±1.8^{d\text{-}f}$	$0.87±0.07^{ab}$
WB_{75}-S_{10}-$C_{7.5}$-$P_{7.5}$	$5.50±0.18^{ab}$	$54.29±2.6^{b\text{-}d}$	$0.90±0.04^{ab}$
WB_{70}-S_{10}-C_{10}-P_{10}	$5.27±0.37^{ab}$	$57.73±2.3^{bc}$	$0.94±0.07^{ab}$

3.6 Organoleptic properties

Organoleptic properties of functional bulgar were carried out using 9-point hedonic scale and results are presented in Table 6. The maximum color score was obtained from WB_{70}-S_{10}-C_{20} (8.20±0.38) followed by WB_{70}-S_{10}-P_{20} (8.11±0.55) and WB_{75}-S_{10}-C_{15} (7.50±0.02) whereas lowest color score was observed in WB_{90}-S_{10} (5.72±0.64) and WB_{100} (5.40±0.92). Similarly, the highest taste score was obtained from WB_{70}-S_{10}-P_{20} (8.19±0.03) followed by WB_{70}-S_{10}-C_{20} (7.81±0.60) whereas lowest taste score was observed in WB_{90}-S_{10} (6.53±0.50) and WB_{100} (5.50±0.42). WB_{85}-S_{10}-$C_{2.5}$-$P_{2.5}$ and WB_{75}-S_{10}-$C_{7.5}$-$P_{7.5}$ values ranged from (5.20±0.36) and ($6.80±0.84^{bc}$). Likewise, maximum texture score of bulgur prepared from WB_{70}-S_{10}-C_{20} (8.09±0.66) followed by WB_{70}-S_{10}-P_{20} (8.02±0.04) and WB_{75}-S_{10}-C_{15} (7.18±0.07b) and lowest texture score was observed in WB_{90}-S_{10} (6.63±0.52) and WB_{100} (5.80±0.43). The texture of bulgur is mainly concerned with isolated kernel and grainy attributes. The varieties having higher thousand kernel weight, grain size, hardness and particle size index intent to perform better in texture of bulgur, control sample WB_{100}, showed value (5.80±0.43), which panelist consider low as compared to WB_{70}-S_{10}-C_{20} and WB_{70}-S_{10}-P_{20} bulgur as it comprised of grainy and non-sticky texture more. Maximum score (8.29±0.63) for mouthfeel has been given to WB_{70}-S_{10}-C_{20}, bulgur prepared with soy and chickpea blend, while the minimum score (5.50±0.52) has been given to WB_{90}-S_{10}. WB_{100} got the score of (6.50±0.44). The overall acceptability ranged from 5.10±0.88 to 8.32±0.48 and suggested that maximum acceptance of bulgur prepared from WB_{70}-S_{10}-C_{20} (8.00±0.98) followed by WB_{75}-S_{10}-P_{15} (8.23±0.52) whereas lowest acceptance was observed in WB_{100} (5.10±0.88). A study

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showed that quality of bulgur prepared with different wheat cultivars showed a significant effect on sensorial attributes [18]. Similar findings to present study reported by [19] who studied nutritional and sensory attributes of kishk prepared from bulgur and whole wheat meal that bulgur size attributed to enhance quality character of kishk Touf.

Table 6: Organoleptic properties of functional bulgar

Treatments	Color	Taste	Texture	Mouthfeel	Overall acceptability
WB_{100}	5.40 ± 0.92^{b}	5.50 ± 0.42^{a}	5.80 ± 0.43^{b}	$5.50\pm0.44a^{b}$	5.10 ± 0.88^{ab}
$WB_{90}\text{-}S_{10}$	5.72 ± 0.64^{a}	6.53 ± 0.50^{a}	6.63 ± 0.52^{a}	6.45 ± 0.52^{a}	7.18 ± 0.75^{ab}
$WB_{85}\text{-}S_{10}\text{-}C_{5}$	6.20 ± 0.46^{c}	6.38 ± 0.35^{a}	5.80 ± 0.63^{cd}	6.20 ± 0.70^{b}	6.02 ± 0.70^{c}
$WB_{80}\text{-}S_{10}\text{-}C_{10}$	7.09 ± 0.70^{d}	7.34 ± 0.02^{de}	7.06 ± 0.01^{de}	7.50 ± 0.61^{c}	7.37 ± 0.12^{d}
$WB_{75}\text{-}S_{10}\text{-}C_{15}$	7.50 ± 0.02^{b}	8.11 ± 0.05^{b}	$7.18\pm0.07b^{a}$	7.21 ± 0.31^{b}	7.47 ± 0.24^{b}
$WB_{70}\text{-}S_{10}\text{-}C_{20}$	8.20 ± 0.38^{c}	7.81 ± 0.60^{a}	8.09 ± 0.66^{d}	8.29 ± 0.63^{b}	8.32 ± 0.48^{a}
$WB_{85}\text{-}S_{10}\text{-}P_{5}$	5.30 ± 0.46^{c}	6.38 ± 0.35^{a}	5.80 ± 0.63^{cd}	6.20 ± 0.70^{b}	6.09 ± 0.70^{c}
$WB_{80}\text{-}S_{10}\text{-}P_{10}$	7.03 ± 0.11^{cd}	7.01 ± 0.05^{c}	7.09 ± 0.16^{c}	7.23 ± 0.91^{a}	6.37 ± 0.17^{cd}
$WB_{75}\text{-}S_{10}\text{-}P_{15}$	7.08 ± 0.03^{a}	7.39 ± 0.65^{cd}	8.39 ± 0.02^{d}	8.18 ± 0.71^{d}	8.23 ± 0.52^{c}
$WB_{70}\text{-}S_{10}\text{-}P_{20}$	8.11 ± 0.55^{b}	8.19 ± 0.03^{a}	8.02 ± 0.04^{b}	7.19 ± 0.15^{a}	7.50 ± 0.45^{c}
$WB_{85}\text{-}S_{10}\text{-}C_{2.5}\text{-}P_{2.5}$	5.20 ± 0.36^{c}	6.27 ± 0.39^{a}	5.60 ± 0.54^{cd}	6.10 ± 0.50^{b}	6.02 ± 0.40^{c}
$WB_{80}\text{-}S_{10}\text{-}C_{5}\text{-}P_{5}$	6.37 ± 0.14^{c}	6.18 ± 0.16^{e}	6.92 ± 0.12^{e}	6.85 ± 0.45^{e}	6.18 ± 0.34^{d}
$WB_{75}\text{-}S_{10}\text{-}C_{7.5}\text{-}P_{7.5}$	6.80 ± 0.84^{bc}	6.41 ± 0.55^{a}	7.01 ± 0.81^{bc}	6.80 ± 0.78^{ab}	7.30 ± 0.65^{a}
$WB_{70}\text{-}S_{10}\text{-}C_{10}\text{-}P_{10}$	6.40 ± 0.98^{c}	6.81 ± 0.60^{a}	7.02 ± 0.66^{d}	7.10 ± 0.63^{b}	6.00 ± 0.98^{a}

CONCLUSION

The present research has been attempted to increase the share of whole wheat in the diets through the developments of value-added products. Currently, wheat is mainly used in the form of whole wheat and white flours. Bulgur is prepared from hard wheat due to high protein content. In Pakistan, soft wheat varieties with better protein content are commercially cultivated. The core objective of the study was to screen out the potential cultivars through various parameters for their bulgur making suitability. The Fakhr e Bakhar-16 performs best among all cultivars.

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