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Evaluation of Different Grains Effects on Nutritional Value and Baking Quality of Afghan Flatbread (Naan)

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Abstract

Afghan Flatbread (Naan) is the staple food in Afghanistan and many other countries; it is consumed by Afghan people even three times per day with any other types of cooked food. In Afghanistan, more than 80% wheat is consumed as flatbread (Naan). It is usually prepared with whole wheat flour, but the nutritional value is not concerned. Therefore, this study examined to improve the nutritional value of Naan by replacing of whole wheat flour (WWF) with composite flours of grains (CFG), such as Chickpea flour (CF), Sorghum flour (SF), Soybean Flour (SBF), and Barley Flour (BF), at different ratios. The baked flatbread was analyzed for physic-chemical characteristics and baking quality. The moisture, ash, protein, texture, loaf height, hardness, and loaf volume of the developed samples were assessed, the moisture recorded (40.15±0.07%) in the fresh baked flatbread containing 100% WWF. The acceptance range of replacement WWF with CFG was (20-47.5%). The added CFG significantly decreased the volume of Naan up to (9.54%) and loaf height up to (19.89%). From the other side, adding CFG increased dough development time, resistance and water absorption capacity compared to WWF dough. The hardness, protein, and ash content of baked bread were also increased.

Keywords: Acceptance Rate, Afghan Flatbread, Baking Quality, Composite Flours of Grains, Nutritional Value, Whole Wheat Flour.

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1. Introduction

Bread is the most famous and oldest wheat based primary staple food throughout the world [1]. It is popular in Afghanistan, India, Iran, Pakistan, North Africa, the Middle East, and many other countries [2]. Flatbread includes many types of breads from different regions with various thicknesses from a few millimeters to few centimeters. Thinner flatbreads are baked rapidly for a short period over heat. On the other side, heavy and voluminous breads are baked for a longer time; therefore, these types of flatbreads have typically brown crusts and a good inner part [3]. The preparation method of Afghan flatbread (Naan) is different in each region, but the basic ingredients are the same [4]. The main ingredients are wheat flour, yeast, water, and salt [5]. Some other additives, ingredients such as milk, butter, oil, sugar, nigella seed, sesame, and many types of grain flours are also used to produce different types of Naan.

Cereals and Legumes (pulses) are the most important crops and have high quality of nutritional value, which are recommended for regular consumption in the human diet. Mostly breads are made from WWF, since thousands of years other important cereals such as maize, barley, rye, soybean, corn, chickpea, etc. have replaced a part of WWF and prepared more nutritive bread for consumers [6]. Studied that bread quality is significantly controlled by the protein quantity and quality, ash, fiber, starch, etc. The incorporation of other flour will slowly influence the dough preparation and final product, the combination of CFG with whole wheat flour for bread making is used in different parts of the world, many studies have shown the positive effects and high quality of specific substitution of whole wheat flour with composite flour of cereal grains. These composite flours' properties increase the nutritional value of bread (Naan). Flatbread is a good source of nutrient and calories [7]. Many types of grains used with wheat flour to produce nutritional flatbread [8]. CFG offers a greater amount of protein, fat [9]. Dietary fiber and minerals compare to wheat and many other flours [10].

Common cereal sources include wheat, maize, and rice [11]. And minor cereals such as barley, millet, oats, rye, and sorghum have also played a traditional role in flatbread production, particularly in African and central Asia regions [12, 13]. Barley is primarily utilized for animal feed and in the malting industry. Only about 2% of barley grain is used for food purposes. The use of barley in human diets has been on the rise in recent years [14]. The incorporation of fiber-rich ingredients, such as barley at levels up to 30%, has been enhancing water absorption while reducing dough extensibility. This modification in dough properties ultimately leads to increased firmness in the final product, such as chapatti [15]. The incorporation of SF and CF has been effects both the nutritional quality and protein content of the developed product [16]. Substituting 40% of wheat flour with CFG in flatbread formulations significantly increased the levels of essential minerals such as iron, calcium, and magnesium, as well as fat, protein, and lysine content, while also improving *i*n vitro protein digestibility [17]. The addition of soybean flour has increased the nutritional quality and protein content of flatbread [16]. The chickpea flour affects on hardening characteristic of flatbread [18].

CFG with WWF for flatbread making has the potential to improve the nutritional and quality of bread [19]. Sorghum flour is rich in phenolic compounds and minerals [20]. Dough made from blend of sorghum and other flours has less sticky and easier to roll

than pure sorghum dough; adding soybean flour enhances better quality for bread [21]. The use of alternative flours in flatbread production hinges on consumer approval of their sensory characteristics, while studies have examined composite flours of flatbreads made of CF, SF, SBF, and BF remain unexplored.

In the present study, composite flour bread was baked using WWF, CF, SF, SBF, and BF to produce enriched Afghan flatbread (Naan). Many developed samples were baked. The ingredients were optimized by using Response Surface Methodology (RSM). These baked samples of Naans with high level of protein, ash and fiber content and were also analyzed their effects on baking quality of Naan, The objective of present research is to prepare good quality and nutritive Afghan flatbread (Naan) from selected CFG and optimum level of used grains flour in the blend by optimizing their level along with nutrition and quality evaluation of multigrain bread.

2. Materials and methods

2.1. Raw materials

The materials used for the preparation of Naan were whole wheat flour, chickpea flour, sorghum flour, soybean flour, barley flour, sugar, yeast, salt, and water. The mentioned flours and dry yeast were purchased from the local market, Table 1. Shows the recipe of Afghan flatbread (Naan) prepared of WWF as control.

Table 1. The recipe of Afghan flatbread (Naan) with the percentage of required ingredients.

No	Ingredients	Amount	Units	Percentage (%)
1	Flour	200	g	55.47
2	Water	150	ml	41.6
3	Sugar	6	g	1.66
4	Salt	3	g	0.85
5	Dried yeast	1.5	g	0.42

2.2 Preparation of composite flour of grains (CFG)

To prepare composite flour, WWF was partially replaced with CF, SF, SBF, and BF. The ratio of CFG was measured in various proportions to formulate different wheat based composite flour mixes. The composite flour was prepared by replacing WWF at different substitution levels (52.5:47.5, 55:45, and 80:20). Table 2, shows the best accepted level of replacement of WWF at different ratios of CFG mix for baked Naan.. The higher overall acceptability score for Naan Table 2, baked of WWF, CF, SF, SBF, and BF was at the ration of: 1-(52.5:15:15:0:17.5), 2-(55:0:15:12.5:17.5), 3-(55:5:5:5:30) and 4-(80:5:5:5:5). The nutritional value and baking quality of prepared Afghan flatbread (Naan) from CFG was assessed. The Afghan Flatbread (Naan) making process is represented in Figure 1.

Table 2. Replacement of CFG at different ratios according to response surface methodology (RSM)

S.No	Wheat flour (%)	Chickpea (%)	Sorghum (%)	Soybean (%)	Barley (%)
C	100	0	0	0	0
1	52.5	15	15	0	17.5
2	55	0	15	12.5	17.5
3	55	5	5	5	30
4	80	5	5	5	5

2.3 Dough preparation

Dough was prepared from 200g of composite flour by hand mixing, followed by the modified method of [22]. Water was added to the flour, other ingredients such as dried yeast, i.e., (Saccharomyces cerevisae), sugar, and salt, added at the ratios of (1.66 and 0.85%). Water added to the flour during kneading to allow the dough to be kneaded by hand up to the desired constancy. The amount of water used is recorded for every sample as water adsorption capacity (WAC) by percentage, as described by Rao, Leelavathi, and Shurpalekar (1986).

2.4 Afghan Flatbread (Naan) making procedure

When the dough was prepared, dough fermented for two hours at 32±2°C and 45% relative humidity, it was shaped as a ball with a diameter of 85 to 90 mm. Each ball is manually shaped by a pin roller to a thickness of 5 to 7mm and 210 to 220mm diameter. After 5 to 7 minutes, the dough disks have to be pressed by finger tips and punched to prevent excessive development during baking, the punching is usually done by bread stamps, which called Bosma in Turkmenistan, then dough disk baked in an electrical oven, figure 2, at a temperature of 375 to 400°C for five minutes. The baked breads were cooled at room temperature and stored in self-sealing low-density polyethylene bags. Table 3 shows the baked samples of Naan at different ratios of CFG.

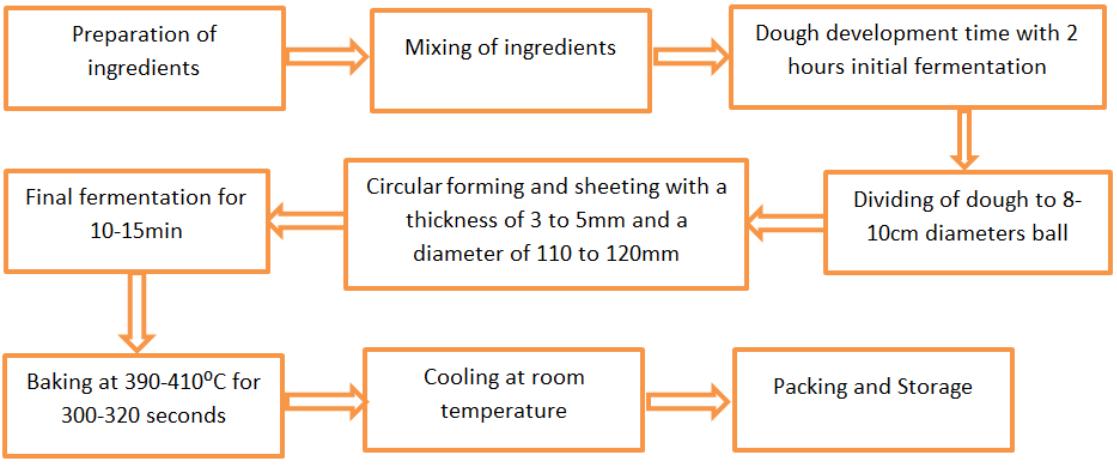


Fig. 1. Afghan Flatbread (Naan) making steps



Fig. 2. Image of an electrical oven for sample baking,

Table 3. The sample of baked Naan with a high acceptance score

Flours name	WWF (Control)	CFG ratio (WWF:CF:SF:SBF:BF)			
		1	2	3	4
Percentages	100	52:15:15:0:17.5	55:0:15:12.5:17.5	55:5:5:5:30	80:5:5:5:5
Image of prepared Naan					

2.5 Baking quality evaluation

Different parameters assessed for the quality of Afghan flatbread (Naan), after baking, the hardness of Naan was measured using by measuring scale and represented in centimeter. The softness of Naan was measured with penetrometer by applying of force in a specific area of the flatbread surface. The loaf weight of bread was measured by weighing of bread loaves 3 to 4 hours after baking. Triplicate values are taken for their observed.

2.6 Sensory evaluation of baked Naan

The bread samples were freshly evaluated for sensory attributes by 20 Afghan students based on the color, flavor, taste, texture, and overall acceptability, the scores given according hedonic scale. The 9-point scale used was included (like extremely, like very much, like moderately, like slightly, neither like nor dislike, dislike slightly, dislike moderately, dislike very much, and dislike extremely. Each flatbread's given score depends on its quality attributes; good quality attributes were indicated by a high score of the hedonic scale.

2.7 Texture

The texture of the flatbreads was assessed using a TA.XT2 Texture Analyser (Stable Micro Systems, Goldalming, UK) fitted with a 25 kg load cell. Two methods were employed: a puncture test and a one-dimensional extensibility test [23, 24]. Both tests

measured rupture force (in Newtons) and rupture distance (in millimeters). Each test was conducted with a minimum of triplicates for every flatbread prototype.

3. Compositional analysis

3.1 Moisture content

Moisture content of the sample was analyzed by the oven drying method [25]. 5g of sample weighted in a dried and previously weighted petri plate, then placed in a hot air maintained of 100^{o}C for one hour, the petri plate was cooled at room temperature ant noted the weight, the heating, cooling, and weighing process was repeated till obtained of constant weight. The values for each sample carried out by duplicate.

3.2 Ash content

For the estimation of ash content, 5g of the sample was weighted in slika dish, which was already weighted, and the sample was carried out in duplicate. The dishes content of samples were directly placed on fire to burn, then the sample residue was kept in a muffle furnace at 550^{o}C for 5-8 hours. The slika dishes cooled and weighted again, the weight difference gave the total ash content and presented as a percentage.

3.3 Total protein

The nitrogen content of the sample was estimated by the Kjeldahl distillation method AOAC (2000). 0.5g weighted sample was digested with 10ml of concentrated H_2SO_4 by heating, and a pinch of digestion composition (composition of 0.3g copper sulphate and 2.7g of potassium sulphate) until the color became clear green. With the help of (40%) NaOH treated digested solution and distilled in a micro Kjeldahl distillation set. The distillate collected in 25ml of (4%) buric acid solution content a drop of mixed indicator (mixture of 2 part 0,2% methyl red and 1 part of 0,2% green solution of bromocresol), after collection of distillate the titration process was done by standard of (0.1N) HCl, during calculation of protein percentage in the sample, dilution factor were taken in to consideration.

3.4 Experimental design

An experimental design approach was employed to optimize various parameters, specifically the maximum range of flour levels across different formulations within a mathematical model. Optimization of the response variables was carried out using Design Expert 10 software. Response Surface Methodology (RSM), a statistical tool for experimental design, was utilized due to its efficiency in minimizing time and cost while providing reliable initial data [26]. The corresponding table outlines the values of each variable tested in the experiments, including the range of composite flour used.

3.5 Statistical analysis

Data obtained of the experimental design were analyzed using Design Expert 10, second order polynomial counted evaluated significance and obtain regression equation, significance of the models analyzed by model analysis and the coefficient determination (R^2) value, [27]. By using SPSS software, calculations were done for mean, standard deviation, and correlation regression.

4. Result and discussion

4.1 Proximate composition of WWF and CFG

The flour content of the recipe used for Afghan flatbread (Naan) was a composite flour blend of WWF, CF, SF, SBF, and BF, and they were analyzed for their proximate composition, which is presented in Table 4.

Table 4. Represents the analyzed proximate composition of CFG individually.

S/No	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Carbohydrate (%)
WWF	10.5 ± 0.71^{d}	1.67 ± 0.16^{b}	10.80 ± 0.49^{b}	1.8 ± 0.13^{a}	75.15 ± 0.57^{c}
CF	11.9 ± 0.14^{e}	2.7 ± 0.00^{c}	21.35 ± 0.37^{c}	5.32 ± 0.19^{c}	58.73 ± 0.45^{a}
SF	9.7 ± 0.14^{c}	1.11 ± 0.00^{c}	10.33 ± 0.62^{a}	3.1 ± 0.09^{b}	75.76 ± 0.61^{c}
SBF	8.8 ± 0.28^{b}	2.81 ± 0.06^{b}	$28..61\pm0.$	7.31 ± 0.11^{d}	62.43 ± 0.47^{b}
BF	8.2 ± 0.57^{a}	1.63 ± 0.16^{b}	10.13 ± 0.71^{a}	2.07 ± 0.15^{a}	77.97 ± 0.74^{d}

4.2 Nutritional Properties of Naan

4.2.1 Proximate Composition

The nutritional profile of Naan was analyzed using standardized procedures. Moisture content was measured according to the AACC method (2000), while protein, ash, fat, and carbohydrate content were assessed using AOAC guidelines (2000). Carbohydrate content was derived by subtracting the combined percentages of moisture, protein, ash, and fat from the total composition. Table 5.

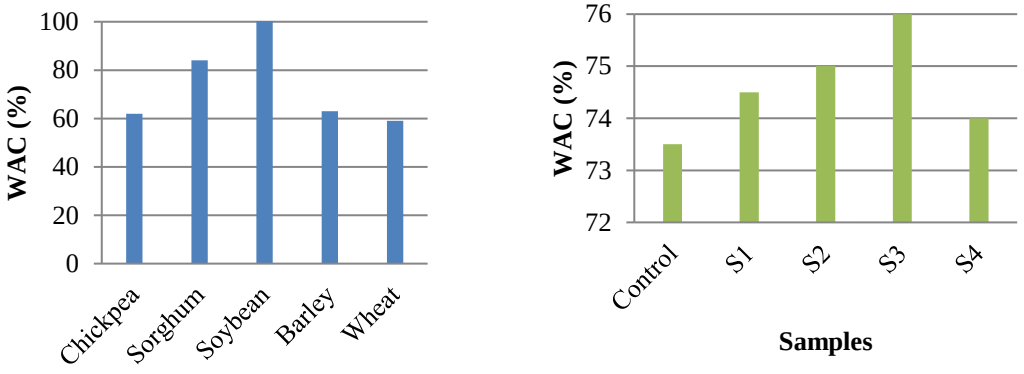
Table 5. Proximate analyses of Afghan flatbread (Naan) used the CFG on a wet matter basis.

Proximate composition					
S.No	Moisture (%)	Protein (%)	Ash (%)	Fat %	Carbohydrate %
C	40.15±0.07	10.8±0.52	1.66±0.013	1.56±0.076	46.59±0.92
1	37.7±0.71	12.19±0.51	1.74±0.062	2.29±0.61	46.01±0.9
2	39.25±0.07	10.96±0.46	1.72±0.027	2.42±0.45	45.96±0.13
3	36.8±0.28	11.24±0.37	1.74±0.025	2.15±0.72	48.88±0.83
4	37.6±0.85	11.41±0.48	1.75±0.026	2.17±0.76	47.41±0.67

4.2.2 Water absorption capacity (WAC) of dough

Several factors, including flour composition, particle size, level of damaged starch, etc., influence water absorption capacity [27, 28]. WAC of dough for applied flour as individually was less. While the flours are blended as composite flour, the WAC was increased at a range of (2.5%) for all samples, composite grains flour had significantly ($\rho > 0.05$) Table 6, higher required to prepare dough, same results reported by Wabu, et al., (2015) and Panghal, et al., (2018) in finger millet chapatti, it is may be because of their high presence of protein. The highest water requirement was for ample (3), which contains (55%) WWF and (45%) of CFG. The result shows that higher in WAC due to its higher protein content, in the sample with more substitution of WWF with BF, SF, and a low level of CF and SBF, showing a decrease of WAC of the dough because of less amount of protein content Figure 3. The amount of increased water for samples (1, 2, 3, and 4), which had an acceptable score of quality was (1%, 1.5%, 2.5% and 0.5) higher than WWF dough, In the case of (Naan), similar findings were made by Rani and Jamuna (2023). The good sheeting properties of dough and softness of baked Naan are

directly related to the high WAC of dough; therefore, Naan preparation needs a higher amount of water addition than the normal WAC of dough. The difference in the observed trend could be due to differences in factors like particle size, extraction rate, or composition.



a b

Fig. 3. a) Shows the WAC of used flours separately, and b) shows the WAC of samples with different ratios of flours.

4.3 Quality evaluation of baked product (Naan)

The experimental Naan was analyzed for proximate composition, the results showed higher level of protein, ash, and fat, which affected on quality of the product. Protein content of developed breads affects due to their quantity and quality, which affects on chewiness, softness, rise of volume, and tearing resistance of Naan. Samples with a high level of protein shows good chewiness and high resistance of tearing, high volume rising, and less hardness; this result is confirmed by Panghal, et al., (2018). The results showed the various ranges of ash content in baked samples, which is noted in Table 5, The ash content of CFG confirms the existence of minerals in the sample and its nutritional value, it is worth mentioning that the ash content resulted in undesirable darkness for dough and baked bread, same result also noted by Panghal, et al., (2006).

4.3.1 Loaf weight

The weight of baked Naans were measured by analytical balance in laboratory condition, the values of loaf weight for samples were noted in Table 7, loaf weight of bread from WWF (control) was 310g, the lowest loaf weight was for sample (1) (8g) because of high percentage of CF, SF and BF, and sample (4) (7g) due to lowest percentage of CFG in blend. This result is similar which reported by Shfali and Sudesh (2001). There is a significance decreasing and increasing of loaf weight due to carbohydrate percentage; the highest loaf weight was observed for sample (3), which has (2.29%) more carbohydrate than the control sample, this indicates extra absorption of water in bread; the same result was seen by Pooran et al., (1991).

4.3.2 Loaf Height and Volume

The bread of 100% WWF had maximum loaf height (1.53cm), and then for sample (4), which was content of (80%) WWF, Table 7. The replacement of WWF by any type of grain flour showed a significant reduction of loaf height ($\rho < 0.05$). Maximum loaf height reduction was seen for samples (1, 2, and 3) (1.4cm), these samples were content (45-47.5%) of CFG, this result confirmed by Yousif (2015). less volume loaf because of less retention capacity of gas in dough ($\rho < 0.05$), which noted by Akubor et al., (2005), and Sekhon, et al., (1999). Loaf volume is decreasing because of dilution of wheat gluten and damage to gluten structure by fiber present in SBF and CF, same results were observed by Adawy et al., (2002). Non-wheat flour has less ability of CO_2 retention which caused compress the loaf volume [28, 29]. The result for loaf height was similar, as reported by Ereifej and Shibli (1993) in breads baked of WWF, the presence of relatively high concentrations of low molecular weight thiols and reduced glutathione, which activate proteolytic enzymes that negatively affect loaf height [30, 31, 32].

4.3.3 Hardness

The hardness evaluation was done by a penetrometer by forcing on a specific ($1cm^2$) surface area of baked product, (Table 6), The results showed that different values for various levels of CFG associated of the blend, was influenced the hardness of Naan. The highest value of (3.07 kg/cm^2) was observed for sample (2) and the lowest value (1.3 kg/cm^2) was for control bread. The results indicated that the level of WWF substitution with CFG increased the hardness of Naan. The increase of SF and SBF level in the blend shows significant effects in reducing the softness of Naan than BF, because the steam gas production during baking leads to rise the volume and the loaf height is higher in whole wheat bread as compare to composite bread. Basically, the gluten network accounts for the extensibility of dough to thus rise in reducing. High in substitution level of wheat flour by composite flour, there is a decline in gluten and thus a restricted rise in volume, a similar result was also observed by Abdelghafor et al., (2010).

Table 6. Shows the loaf weight, loaf height and hardness of Naan.

S.No	Loaf weight (g)	Loaf height (cm)	Hardness (kg/cm^2)
C	310	1.53±0.07	1.3±0.1
1	302	1.4±0.28	2.5±0.1
2	311	1.4±0.07	3.07±0.31
3	313	1.4±0.07	2.3±0.17
4	303	1.5±0.14	2.03±0.06

4.3.4 Sensory evaluation of Naan

The sensory evaluation of the developed bread was carried out as per the hedonic scale. Table 7 Sample (1, 3, and 4) scored above 8 and sample (2) scored below 8; this indicates that these samples were acceptable. The highest score of all sensory characteristics after the control sample was given for sample (4). The quality attributes

of these acceptable samples were closer to the control baked Naan. During sensory evaluation, the taste, texture, and flavor score of all samples were more affected by replacement of WWF with high levels of CF, SF, and SBF, but the level of BF had little influence as other composite flours on the acceptability of scores.

Table 7. Sensory evaluation of developed samples according to hedonic scale.

Sensory evaluation					
S.No	Color	Flavor	Taste	Texture	over all acceptability
Control	8.6	8.7	8.5	8.7	8.62
1	7.8	8.2	7.5	8.5	8
2	7.8	7.5	7.5	8.5	7.83
3	8.5	8.5	7.5	8.5	8.25
4	8.3	8	8.5	8.5	8.33

4.3.5 Crust color

The changes to increase the level of applied composite flour in the blend, the crust color of baked breads changed from brown-creamy to yellowish brown, also, the high level of chickpea and soybean flour in the blend increased the yellowish to brown golden color, but high level of BF and SF increased the white to dull brown color. The color of highly accepted Naans is presented in Figure 3, Control WWF bread was lighter than any other baked samples; a similar result was observed by Idriss, et al., (2012). The darker crust color is because of a great amount of Maillard's reaction between protein and reducing sugar when reacting with the free amino acids side chain of protein during baking, which means polymerization of protein and forming of brown color [33]. Table 3 represents the appearance color of baked samples.

4.3.6 Flavor

Results for flavor evaluation of baked products shown in Table 7 among the baked breads the highest score observed for sample (4) content of composite flour (WWF:CF:SF:SBF:BF) at the ratio of (80:5:5:5:5) and then sample (3) content composite flour at the ratio of (55:5:5:5:30). However there was decreasing of flavor score by decreasing of WWF substitution in the blends which is noted by Sharma and Chauhan (2000).

4.3.7 Texture of bread

The texture of bread is related to the internal appearance of the baked product, Figure 4, the formation of porosity to rise the volume and softness texture of Naan depends on the amount of WWF; the scores of texture analysis for all prepared samples are the same. The results show that the added level of CF, SF and SBF in the blend decreases the porosity of the texture because chickpea and sorghum increased hardness, and soybean had a high level of fat content, but the barley flour up to (30%) did not decreased the score significantly. The overall score of texture is given in Table 7.

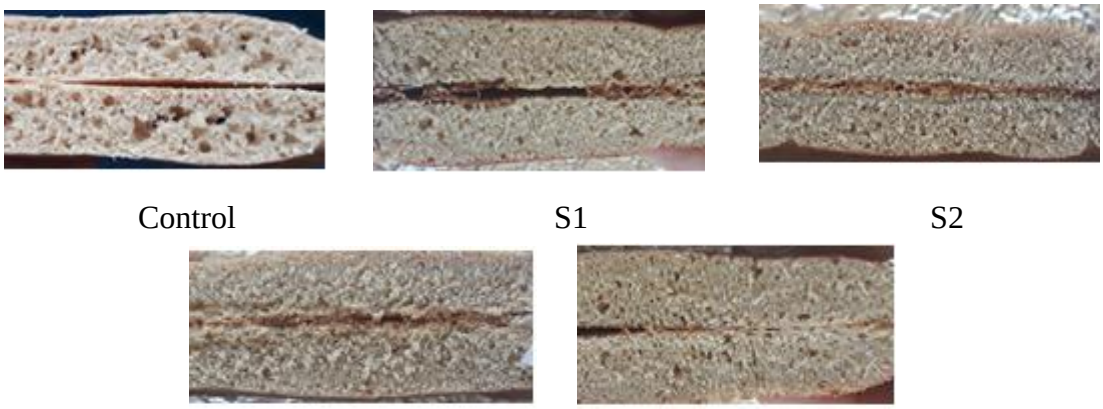


Fig. 4. Represents the crumb texture of accepted baked Naan samples.

4.3.8 Taste

The taste evaluation was compared with control baked bread, the results indicated a different range of scores, which is noted in Table 7. The high amount of CF, SF, and SBF in blends decreases the score of tasted naan because of heavy flavor, which is noted by Rastogi and Singh (1989). The replacement of WWF for sample (4) with the same level of CFG had (8.5) score of taste, which indicates a high score.

4.3.9 Overall acceptability

The overall acceptability degree is the mean score of color, flavor, taste, and texture characteristics. Table 7 represents the result of overall acceptability for all prepared Naan samples, the sample (4) replaced of WWF by (20%) level of CF, SF SBF and BF had acceptance score of (8.33) and it had more close quality characteristic to control bread, but the sample (2) baked of (0, 15, 12.5 and 17.5%) level of CF, SF, SBF and BF had the lowest (7.83) overall acceptability score. The increasing level of CF, SF, and SBF in the blend decreased the overall acceptability of bread. The 4 accepted baked samples of Naan were supplemented WWF with the level of (0-15%) CF, (5-15%) SF, (0-12.5%) SBF, and (5-30%) of BF in the blend. The presented level was also confirmed by Zhao, et al., (2006) and Wood (2009).

4.4 Conclusion

The present article highlights that the Afghan flatbread (Naan) prepared of composite flour of WWF, CF, SF, SBF, and BF with a replacement of (20-47.5%) increased the amount of fat, protein, and ash than the control flatbread prepared of 100% WWF. The addition of mentioned composite flours of grains affected on rheological characteristics and water adsorption capacity of dough, also the CFG blend resulted in higher hardness of Naan, A high percentage of BF, up to 30% in the CFG blend had more close baking quality and sensory characteristics to control sample of 100% WWF. But there was less porosity in the texture for the CFG samples compared to 100% of the WWF Naan,

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