

The assessment of leavened and unleavened flat breads properties enriched with wheat germ

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RESEARCH ARTICLE

Abstract

Wheat germ is a good source of protein, minerals, vitamins, phytochemicals and dietary fibre. In this study, coarse wheat germ (CWG) and fine wheat germ (FWG) were used in the formulations of leavened flat bread (bazlama) and unleavened flat bread (yufka) at three different ratios (10, 20 and 30%). Some physical, chemical and sensory properties of both flat breads were determined. Surface colour of flat breads containing CWG/FWG became darker, more reddish and yellowish compared to control breads. The ash, protein and fat content of flat breads improved with increasing amount of CWG/FWG in flat bread formulation. A significant ($P<0.05$) increase was also obtained in Fe, K, P and Zn contents of the flat breads in all usage levels of CWG/FWG. As a result of sensory evaluation, leavened flat breads containing CWG had higher overall acceptability scores than leavened flat breads prepared with FWG. CWG usage over 20% level in leavened flat bread and over 10% level in unleavened flat bread caused a decrement in overall acceptability scores of flat breads.

Keywords: wheat germ, flat bread, bazlama, yufka

1. Introduction

Wheat germ (WG) constitutes 3.0% of whole grain and is obtained as by-product of the flour milling industry. WG proteins provide high nutritive value comparable to animal proteins. It has significant quantity of essential amino acids especially lysine which is deficient in many cereals (Ge *et al.*, 2000; Rao *et al.*, 1980a). WG is also a rich source of vitamins, minerals, unsaturated fatty acids, free sugars and functional phytochemicals including ferulic acid, phytic acid, glutathione and phytosterols (Al-Hooti *et al.*, 2002; Kevin, 1995; Sidhu *et al.*, 2007). WG provides three times as much protein, seven times as much fat, six times as much mineral contents compared to wheat flour (Rao *et al.*, 1980b). WG has good potential for increasing the nutritional status of many foods such as bread, macaroni, cookie, and tarhana, due to the rich composition of WG (Arshad *et al.* 2007; Bajaj *et al.*, 1991; Gómez *et al.*, 2012; Pınarlı *et al.*, 2004; Sidhu *et al.*, 1999).

Breads are the staple foods in diets of people in Turkey. The main ingredient of bread is generally refined wheat flour which is rich in carbohydrate. Breads are important vehicle for nutritional enrichment. For adequate and balanced nutrition of school-going children and adults it can be produce with high nutritive value with supplementation of different ingredients containing high amount of protein, mineral, fibre and vitamin. Bazlama, lavash, yufka and pide are widely produced traditional leavened and unleavened flat bread types of Turkey. Bazlama can be defined as leavened flat bread (LFB) with a creamish yellow colour. It has a circular shape with an average thickness of 3 cm and a diameter ranging from 10 to 20 cm (Başman and Köksel, 1999). Yufka is unleavened flat bread (UNFB) with 1-2 mm thickness and 40-50 cm diameters (Başman and Köksel, 2001). Yufka have lower thickness, higher surface area, lower moisture content and longer shelf life than bazlama. Generally, bazlama and yufka are produced from refined white wheat flour in Turkey. In rural areas of Turkey,

wheat flour with high extraction ratio is preferred in the production of these flat breads.

Some laboratory studies have been conducted for enrichment of Turkish flat breads. For these purpose barley flour and wheat bran (Başman and Köksel, 1999, 2001), triticale flour (Coşkuner and Karababa, 2005), resistant starch (Levent *et al.*, 2012), dairy by-products (Madenci *et al.*, 2012), legume flours (Levent and Bilgiçli, 2012a), lupin, buckwheat and oat flours (Levent and Bilgiçli, 2012b; Yıldız and Bilgiçli, 2012) have been used in Turkish LFB and UNFB production.

The objectives of this research were to increase the nutritional profile of flat breads by usage of WG with two particle size and to evaluate the influence of WG level on physical, chemical and sensory quality of LFB and UNFB.

2. Materials and methods

Materials

The wheat flour which was used in flat bread production was commercial flour with a crude protein and ash content of 11.85 and 0.51%, respectively. WG was obtained from a flour mill in Konya, Turkey. The stabilisation of WG was performed by microwave heating in home-type rotating microwave oven (2,450 Hz, 700 W; Arçelik, Istanbul, Turkey) for 5 min according to our previous study (Levent and Bilgiçli, 2013). Stabilised WG was ground with coffee grinder. Coarse (750–500 µm) wheat germ (CWG) and fine (500–250 µm) wheat germ (FWG) was obtained by using 250, 500 and 750 µm sieves (İmaş makine, Konya, Turkey).

Preparation of leavened and unleavened flat bread samples

LFB and UNFB samples were prepared according to the method given by Akbaş (2000) and Başman and Köksel (2001), respectively. For preparation of control LFB, wheat flour (200 g, 14% moisture basis), salt (3 g), sugar (2 g), fresh yeast (5 g) and water, and for preparation of control UNFB, wheat flour (200 g, 14% moisture basis), salt (3 g) and water were used as ingredients. For preparation of LFB/UNFB containing WG, wheat flour replaced with CWG or FWG at 10, 20 and 30% levels in flat bread formulation. All ingredients and water (according to farinogram absorption value) were mixed in a Hobart mixer (Hobart N50; Canada Instruments, North York, Ontario, Canada) for optimum dough development for both LFB and UNFB samples. After mixing, the dough was allowed to ferment at 30 °C for 1 h and divided into two equal pieces and rounded into a ball shape and allowed to rest for 6 min at room conditions for LFB preparation. After that, dough was sheeted to final thickness of 10 mm by using stainless steel circle of 17 cm diameter and baked at 280±5 °C for 5 min on sac (metal

plate heated by electrical resistances, 1,500 W). For UNFB samples, mixed dough was fermented at 30 °C for 30 min and then dough was divided into 4 pieces and rounded into a ball shape. The dough balls were rolled to the final possible thickness and baked at a temperature of 280±5 °C on a sac for 1 min. After cooling at room conditions for 1 h, physical and sensory analyses were performed and the remaining bread samples were stored in plastic bags for chemical analyses.

Physical measurements

Diameter and thickness of LFB and UNFB samples were determined according to Yıldız and Bilgiçli (2012). The spread ratio values of samples were found by dividing diameter to thickness value of flat breads. Minolta CR-400 (Konica Minolta Sensing, Inc., Osaka, Japan) chromameter was used to record the L* (lightness/darkness), a* (redness/greenness), and b* (yellowness/blueness) colour parameters of flat breads. The saturation index (SI) was calculated as:

$$SI = (a^*2 + b^*2)^{1/2}$$

Chemical analyses

Samples were analysed for their moisture, ash, protein and fat content using approved methods of American Association of Cereal Chemists (AACC, 1990). For mineral analysis, 0.3 g dried sample was put into burning cup and 10 ml HNO₃+H₂SO₄ were added. The samples were incinerated in a microwave oven (MARS 5; CEM Corporation, Matthews, NC, USA). The solution was diluted with distilled water to 100 ml. Concentrations were determined by inductively coupled plasma atomic emission spectrometer (Vista series; Varian International AG, Zug, Switzerland) (Bubert and Hagenah, 1987).

Sensory analyses

The sensory evaluation of LFB and UNFB samples containing CWG and FWG was conducted with 22 panellists (age range of 27 to 50). Flat bread samples were presented in a random order to each panellist separately on the same day. The panellists were asked the score for appearance, shape and symmetry, texture, mouthfeel, taste-odour and overall acceptability of LFB and for appearance, elasticity, mouthfeel, taste-odour and overall acceptability of UNFB samples on a 9 points scale were: 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much, and 9 = like extremely.

Statistical analyses

Data were subjected to analyses of variance (ANOVA) with two factors: WG particle size (coarse/fine) and WG replacement level (0, 10, 20 and 30%). The analysis of variance (ANOVA) was performed using the Statistical software JMP 5.0.1 (SAS Institute, Cary, NC, USA). The comparison of the means was made by using Student's t-test. Significant differences were based on $P < 0.05$.

3. Results and discussion

The diameter, thickness and spread ratio of flat bread samples are presented in Table 1. According to particle size variance source, particle size of WG did not significantly ($P > 0.05$) affect the diameter, thickness and spread ratio of LFB samples. Addition of CWG/FWG at 10-30% levels decreased the thickness thus increased the spread ratio of LFB samples comparing to control bread. Diluting gluten content with CWG/FWG addition may cause this decrease in thickness. There are numerous studies in the literature about decreasing volume or thickness of breads with the substitution of non-gluten flours or bran (Gómez *et al.*, 2012; Rao *et al.*, 1980b; Sidhu *et al.*, 2001). The thickness reduction of breads may be tolerated to some extent but too much reduction is undesirable. Because it leads to deteriorate in crumb structure and reduces the eating quality of breads.

Table 1. Some physical properties of flat bread samples.¹

	Diameter (cm)	Thickness (cm)	Spread ratio
Leavened flat bread			
Particle size			
CWG	16.78a	1.08a	15.76a
FWG	16.67a	1.13a	14.88a
CWG/FWG ratio (%)			
0	16.85a	1.26a	13.50b
10	16.75a	1.00b	16.79a
20	16.67a	1.08b	15.52a
30	16.65a	1.08b	15.50a
Unleavened flat bread			
Particle size			
CWG	32.60b	0.11a	294.61b
FWG	33.26a	0.10a	327.528a
CWG/FWG ratio (%)			
0	32.05c	0.12a	279.24c
10	32.58bc	0.11a	289.71c
20	33.25ab	0.10a	317.59b
30	33.85a	0.09a	357.72a

¹ Means followed by the same letter within a column are not significantly different ($P < 0.05$).

CWG = coarse wheat germ; FWG = fine wheat germ.

According to particle size variance source, FWG usage in UNFB gave higher diameter and spread ratio compared to CWG usage. FWG could have less detrimental effect on gluten network of dough due to smaller particle size than CWG. High level of CWG/FWG (20-30%) usage in flat bread formulation gave higher diameter and spread ratio in UNFB compared to control UNFB without WG.

The colour values of LFB and UNFB samples are given in Table 2. Particle size of the WG affected the b^* and SI values of the LFB samples. FWG usage in LFB gave lower b^* and SI values than CWG. L^* , a^* and b^* values were 77.32, 1.68 and 28.76 for CWG, and 78.14, 1.34 and 27.95 for FWG (data not shown). Utilisation of CWG/FWG into both flat breads formulation decreased the L^* values but increased a^* and b^* values of breads significantly ($P < 0.05$) at all replacement levels. Compared to wheat flour, dark, more reddish and yellowish colour of CWG/FWG due to its natural pigmentation, significantly affected the colour parameters of the final product, flat breads. On the other hand, high sugar and protein content of WG may be increased Maillard reaction and also sugar caramelisation which resulted in higher darkness and redness on final product. Similarly, Al-Hooti *et al.* (2002) reported that crumb L^* values of pan bread decreased, a^* and b^* values increased with the increasing WG levels (10-20%). It is

Table 2. Colour values of flat bread samples.¹

	L^*	a^*	b^*	SI
Leavened flat bread				
Particle size				
CWG	69.72a	0.64a	20.42a	20.47a
FWG	70.45a	0.63a	19.54b	19.59b
CWG/FWG ratio (%)				
0	74.12a	-1.14d	16.38c	16.42d
10	71.98b	-0.17c	18.32b	18.32c
20	67.20c	1.58b	22.24a	22.30b
30	67.04c	2.31a	22.98a	23.09a
Unleavened flat bread				
Particle size				
CWG	68.95a	0.26a	17.92a	17.95a
FWG	69.43a	0.25a	17.46a	17.49a
CWG/FWG ratio (%)				
0	78.19a	-0.99d	16.41c	16.44c
10	68.76b	-0.37c	17.42b	17.42b
20	65.63c	0.77b	17.95b	17.96b
30	64.18d	1.61a	18.99a	19.05a

¹ Means followed by the same letter within a column are not significantly different ($P < 0.05$).

L^* = lightness/darkness; a^* = redness/greenness; b^* = yellowness/blueness; SI = saturation index; CWG = coarse wheat germ; FWG = fine wheat germ.

reported that WG enriched macaroni samples (at 15% levels) were found darker and more reddish compared to control macaroni (Pinarlı *et al.*, 2004).

Particle size of the WG did not significantly affect chemical composition of LFB and UNFB samples. As expected, ash, protein and fat content of LFB and UNFB samples increased significantly ($P < 0.05$) with the increasing levels of CWG/FWG (Table 3). Ash, protein, fat content of CWG (4.15, 26.71 and 8.52%), FWG (4.19, 26.40 and 8.63%) were found to be considerably higher than WF (0.51, 11.85 and 0.92%) (data not shown). Compared to control breads, ash, protein and fat content of flat breads increased 1.76, 1.36 and 3.02 times in LFB and 1.89, 1.40 and 3.92 times in UNFB at highest replacement level (30%) of CWG/FWG. Sidhu *et al.* (1999) reported that the ash, protein and fat contents improved in all high-fibre toast bread samples containing increased levels of WG and bran. In another study, cookies supplemented with defatted WG (at 5-25% levels) were found to be nutritious on the basis of protein, fat, ash and mineral contents (Arshad *et al.*, 2007).

Table 4 shows the mineral compositions of LFB and UNFB samples. As observed in chemical analysis results (Table 3), particle size of the WG also did not significantly ($P > 0.05$) affect the mineral content of the LFB and UNFB samples (Table 4). On the other hand, the rich mineral contents of

CWG/FWG increased the mineral contents of LFB and UNFB significantly ($P < 0.05$). Cu, Fe, K, P and Zn content was 0.82, 8.45, 741.65, 770.16 and 11.25 mg/100 g for CWG, 0.91, 8.45, 745.17, 774.42 and 10.87 mg/100 g for FWG and 0.43, 1.48, 145.80, 128.75 and 0.87 mg/100 g for wheat flour, respectively (data not shown). LFB and UNFB containing 30% CWG/FWG had the highest Fe, K, P and Zn content. The recommended dietary allowances for adult males are 10 mg Fe, 1,600-2,000 mg K, 800 mg P, and 15 mg Zn (Demirci, 2007). When 100 g (dry matter) of LFB containing 30% CWG was consumed, 32.7, 21.6, 37.4 and 29.2% of recommended dietary allowances for Fe, K, P and Zn can be provided in human body, respectively. These recommended dietary allowance ratios were 14.0% of Fe, 9.6% of K, 9.5% of P and 8.1% of Zn in the control LFB made with wheat flour. Abd El-Hady (2012) reported that biscuits supplemented with defatted WG flour (at 5-25% levels) had high values of P, K, Ca, Fe, Mg and Zn comparing with control.

Sensory properties of LFB and UNFB breads are presented in Figure 1 and Figure 2. Appearance and shape-symmetry scores of LFB decreased sharply over 20% level of CWG and over 10% level of FWG. In UNFB, CWG over 10% addition level decreased appearance and elasticity scores of the samples. The characteristic pleasant taste and flavour of WG had positive effect on the mouthfeel and taste-odour

Table 3. Chemical properties of flat bread samples. Ash, protein and fat values are based on dry matter.¹

	Moisture (%)	Ash (%)	Protein (%)	Fat (%)
Leavened flat bread				
Particle size				
CWG	35.80a	1.76a	13.94a	2.29a
FWG	35.82a	1.79a	13.83a	2.24a
CWG/FWG ratio (%)				
0	34.75c	1.26d	11.74d	1.14d
10	35.45b	1.62c	13.20c	1.89c
20	36.30a	1.99b	14.60b	2.61b
30	36.75a	2.22a	16.02a	3.44a
Unleavened flat bread				
Particle size				
CWG	7.09a	1.62a	13.69a	1.87a
FWG	7.04a	1.67a	13.77a	1.92a
CWG/FWG ratio (%)				
0	6.68b	1.14d	11.50d	0.79d
10	6.80b	1.52c	13.03c	1.51c
20	7.25ab	1.78b	14.34b	2.18b
30	7.54a	2.16a	16.06a	3.10a

¹ Means followed by the same letter within a column are not significantly different ($P < 0.05$).

CWG = coarse wheat germ; FWG = fine wheat germ.

Table 4. Mineral contents of flat bread samples (mg/100 g). Values are based on dry matter.¹

	Cu	Fe	K	P	Zn
Leavened flat bread					
Particle size					
CWG	0.38a	2.37a	279.30a	187.78a	2.89a
FWG	0.40a	2.37a	282.31a	188.51a	2.71a
CWG/FWG ratio (%)					
0	0.29c	1.40d	172.56d	75.68d	1.22d
10	0.35bc	2.08c	245.30c	152.57c	2.24c
20	0.43ab	2.73b	315.98b	224.32b	3.36b
30	0.48a	3.27a	389.45a	299.12a	4.38a
Unleavened flat bread					
Particle size					
CWG	0.36a	2.23a	273.67a	182.06a	2.74a
FWG	0.39a	2.27a	272.31a	183.52a	2.55a
CWG/FWG ratio (%)					
0	0.24c	1.21d	154.36d	64.00d	0.84d
10	0.32bc	1.75c	225.64c	140.40c	1.85c
20	0.38ab	2.35b	301.26b	212.30b	2.96b
30	0.44a	3.09a	371.49a	288.70a	4.10a

¹ Means followed by the same letter within a column are not significantly different ($P < 0.05$).

CWG = coarse wheat germ; FWG = fine wheat germ.

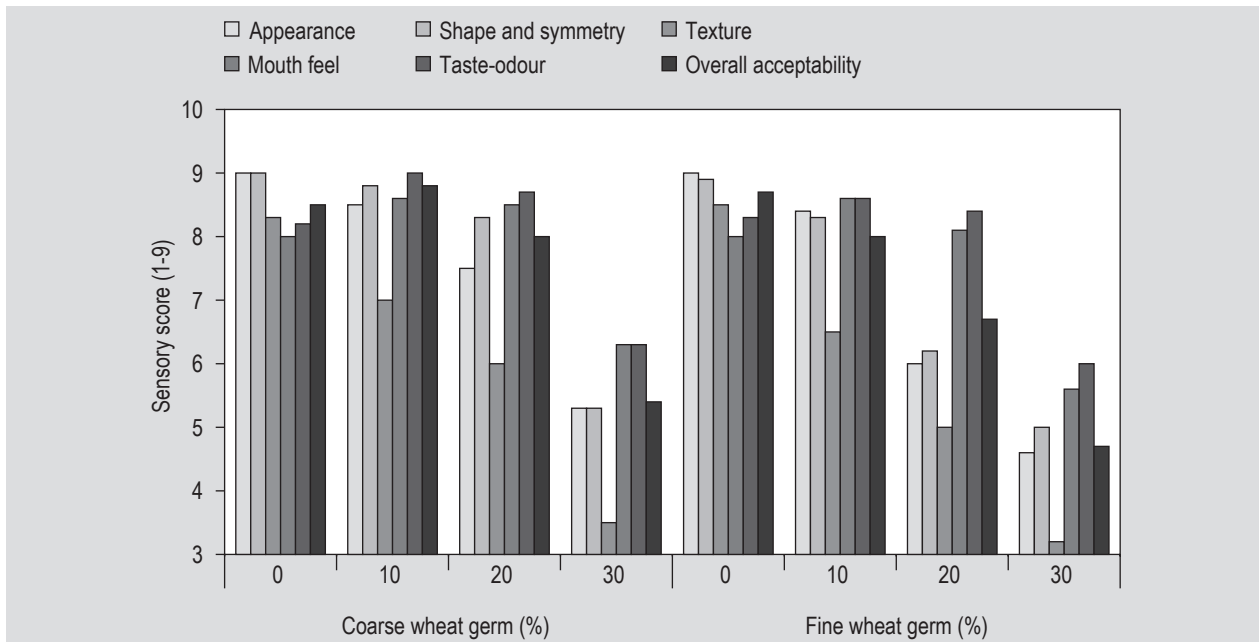


Figure 1. Sensory scores of leavened flat bread samples.

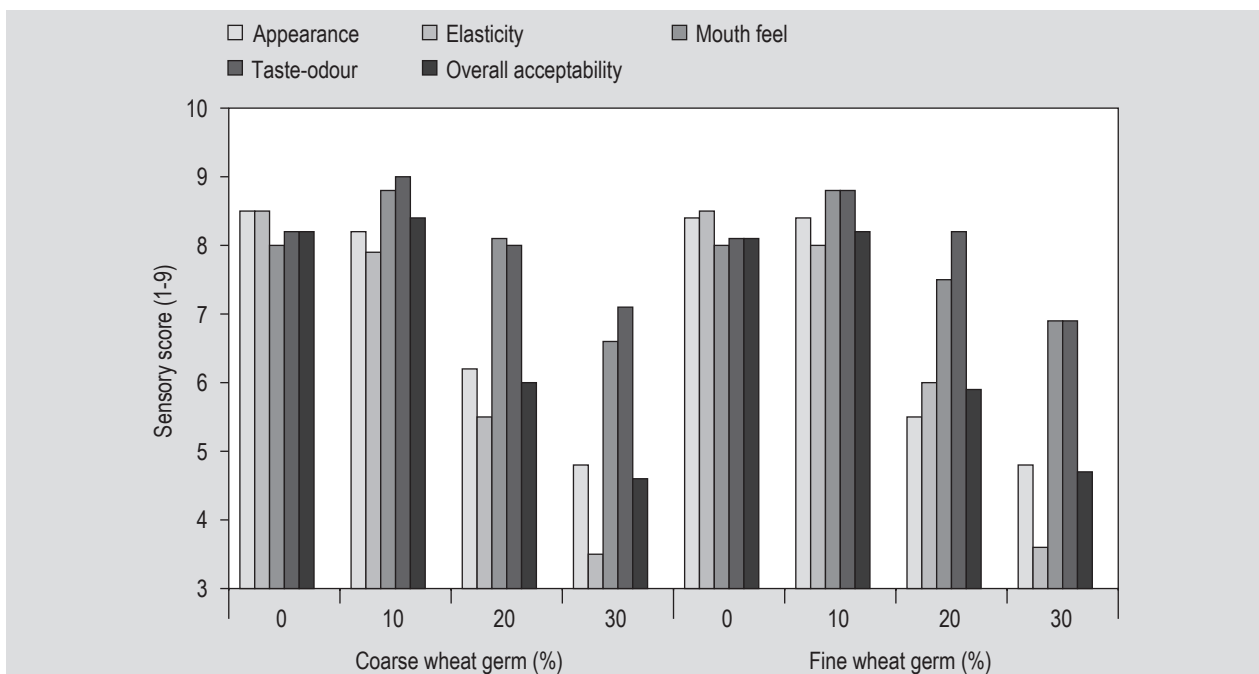


Figure 2. Sensory scores of unleavened flat bread samples.

of LFB (up to 20% CWG/FWG level) and UNFB (up to 10% CWG/FWG level). Sidhu *et al.* (1999) reported that high-fibre bread containing 20% bran and 7.5% WG had higher eating quality than the conventional whole wheat flour bread. Sidhu *et al.* (2001) observed that the incorporation of WG into the white bread formulation enhanced the nutritional profile of enriched bread samples and also improved the sensory characteristics of bread made from wheat flour. Generally, overall acceptability scores of LFB containing

CWG found higher than flat bread prepared with FWG. CWG usage over 20% level in LFB and over 10% level in UNFB decreased overall acceptability scores of flat breads. High levels of CWG/FWG may have detrimental effect on technological and sensorial properties of flat breads due to gluten diluting effect of WG in bread formulation. Gómez *et al.* (2012) stated that the addition of 10% WG had no negative effect on bread taste but significant differences were observed in volume and texture of breads.

4. Conclusions

The effect of WG particle size and WG addition level on the physical, chemical and sensorial quality of Turkish flat breads (bazlama and yufka) were investigated. CWG/FWG usage in flat bread formulation decreased the thickness and increased the spread ratio value of LFB samples. The diameter and spread ratio of UNFB breads containing FWG was found higher than that of UNFB prepared with CWG. The diameter and also spread ratio values of UNFB samples increased with the increasing levels of CWG/FWG. The ash, protein, fat and mineral content (Fe, K, P, Zn) of LFB and UNFB samples were found superior than control breads prepared with refined white wheat flour. An increase in darkness, redness and yellowness of flat breads with the addition of CWG/FWG were observed. CWG/FWG usage up to 20% level in LFB and up to 10% level in UNFB improved sensorial profile in terms of mouthfeel and taste-odour. Other sensory attributes decreased with high addition levels of CWG/FWG in LFB and UNFB.

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