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Improvement of bread kadayıf formulation with wheat germ addition and different fermentation methods

Ekmek kadayıfı formülasyonunun ruşeym katkısı ve farklı fermantasyon yöntemleriyle geliştirilmesi

Zeliha Fidan [1], Kübra Aktaş[2,*]

[1,2] *Karamanoğlu Mehmetbey University, Faculty of Applied Sciences, Department of Gastronomy and Culinary Arts, 70200, Karaman, Türkiye*

Abstract

In this study, it was aimed to improve the functional properties of bread kadayıf. For this purpose, 30% of the wheat flour was replaced with wheat germ, and the samples were fermented in 3 different methods including active dry yeast, sourdough and chickpea yeast. Selected physical, chemical and sensorial properties were examined in the final samples. The use of chickpea yeast increased ash content, antioxidant activity, and total phenolic content. The amount of phytic acid reached higher values in the samples with wheat germ, but sourdough and chickpea yeast addition decreased phytic acid content both in the samples with and without germ. On the other hand, the mineral amounts of the samples (Ca, K, Fe, Zn) increased with wheat germ. When the sensory analysis results were examined, it was seen that the use of wheat germ did not have any negative effects on the bread kadayıf samples and active dry yeast added samples had higher overall acceptability scores compared to sourdough and chickpea yeast.

Keywords: Bread kadayıf, Chickpea yeast, Phytic acid, Sourdough, Wheat germ

Özet

Bu çalışmada ekmek kadayıfının fonksiyonel özelliklerinin geliştirilmesi amaçlanmıştır. Bu amaçla buğday ununun %30'u buğday ruşeymi ile yer değiştirmiş ve örnekler aktif kuru maya, ekşi maya ve nohut mayasını içeren 3 farklı yöntemle fermente edilmiştir. Nihai örneklerde bazı fiziksel, kimyasal ve duyusal özellikler incelenmiştir. Nohut mayasının kullanımı kül içeriğini, antioksidan aktiviteyi ve toplam fenolik madde miktarını arttırmıştır. Ruşeym içeren örneklerde fitik asit miktarı daha yüksek değerlere ulaşmış ancak ekşi maya ve nohut mayası ilavesi hem ruşeymli hem de ruşeymsiz örneklerde fitik asit içeriğini azaltmıştır. Diğer taraftan, örneklerin mineral miktarları ise (Ca, K, Fe, Zn) ruşeym ile birlikte artış göstermiştir. Duyusal analiz sonuçları incelendiğinde, ruşeym kullanımının ekmek kadayıfı örneklerinde herhangi bir olumsuz etkisinin olmadığı ve aktif kuru maya ilaveli örneklerin ekşi maya ve nohut mayası ilaveli örneklere göre genel kabul edilebilirlik puanlarının daha yüksek olduğu görülmüştür.

Anahtar kelimeler: Ekmek kadayıfı, Nohut mayası, Fitik asit, Ekşi maya, Ruşeym

1 Introduction

Consumer awareness has considerably ascended about healthy lifestyles and consumer demand for healthier products continues to increase worldwide. In this context, the largest market segment can be considered under the title of 'naturally healthy and fortified/functional' products [1]. On the other hand, recent researches on functional products have concentrated on traditional products as well as global products.

Desserts have always formed an important part of meals and have been served at special times and the desserts have been mentioned with high energy due to used ingredients [2]. Kadayıf is one of the most known desserts in Turkish cuisine and it can be defined as a sweet pastry with different types such as stuffed kadayıf, string kadayıf, bread kadayıf, künefe, white kadayıf, tray kadayıf, creamy kadayıf, palace wire kadayıf etc. The history of bread kadayıf dates back to earlier times as well as other kadayıf types. It is known that soldiers consumed bread kadayıf by pouring sherbet on dry stale breads during expeditions. The consumption of bread kadayıf has modified over time and reached today's industrial production level. It is notified that the used flour for bread kadayıf production should be suitable and the end product should be thin and of equal thickness on all sides [3].

The sourdough as a natural fermentation process has attracted attention again in the recent times due to additional health and nutritional benefits although nowadays industrially produced yeast and chemical yeast agents have been used [4]. Besides, high volume and shelf life, microbiologically safe product, and good sensory characteristics were aimed with sourdough utilization in bread-making technology [5]. Sourdough is produced with wheat flour and water but it can also be obtained from other flour sources that is, rye, oat, barley, corn, etc. and using of these another sources can be resulted with various nutritional values and organoleptic properties [5, 6]. For example, "chickpea yeast" is used in some regions such as Turkey, Macedonia and Greece, as a result of this, distinctive odour and taste are obtained in some bakeries. Chickpea yeast can be described as a filtrate from fermented mixture of coarsely grounded chickpea, salt and water. The fermentation is commonly applied at 37-40°C for 16-18 hours. The sponge

* Sorumlu yazar / Corresponding author, e-posta / e-mail: kubraaktas@kmu.edu.tr (K. Aktaş)
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which contains the filtrate, wheat flour and salt is used for "chickpea bread or bread with sweet ferment" [7]. The microbiota in sourdough is originated from fermented dough and especially lactic acid bacteria and yeasts are commonly dominant organisms. When the lactic acid and acetic acid concentration increase in the mixture, a sour taste is achieved. It was reported that decreasing the risk of some diseases such as colorectal cancer, cardiovascular disorders, diabetes, and obesity can be accomplished with sourdough products consumption [5, 6].

Wheat germ is one of the three important structures of whole wheat. This part is separated from endosperm and bran during milling process as a nutritious by-product. It may be considered as a concentrate source of essential amino and fatty acids, minerals, vitamins, tocopherols and phytosterols. Refined wheat flour and its derived cereal products are poor in point of micronutrients and dietary fiber. Recently most cereal based food products have been fortified with wheat germ for nutritional improvement. Nevertheless, some studies notified that using of germ in bread making showed some undesirable effect on the viscoelastic properties of dough and some methods as heating, fermentation and antioxidant addition have been suggested [8].

To the best of our knowledge there is very little information about bread kadayıf. To address this gap, the present study aimed to determine how wheat germ addition and different fermentation methods affect the quality characteristics of bread kadayıf samples.

2 Material and methods

2.1 Materials

Materials needed for the preparation of bread kadayıf samples; white wheat flour, sunflower oil, butter, eggs, refined table salt, granulated sugar, active dry yeast were obtained from local markets in Karaman. Chickpeas were purchased from a local legume retailer. Wheat germ was obtained from İngro Food Marketing, Turkey.

2.2 Sourdough fermentation

For sourdough fermentation, 20 g organic wheat flour, 20 g organic rye flour and 40 ml water were mixed homogeneously in a sterile container with a wooden spoon to avoid metal contact and left for 48 hours. Afterwards, 20 g of dough mixture was fed by mixing 20 g of organic rye flour, 20 g of organic wheat flour and 40 ml of water without metal contact, 3 times in a day for 15 days. At the end of 15 days, 10 g of the resulting sourdough was taken and 50 g of wheat flour and 50 ml of water were added and fed twice a day. Sourdough, fed for 30 days in total, was used in bread kadayıf [9].

2.3 Chickpea yeast fermentation

For chickpea yeast fermentation, 100 g of coarsely crushed chickpeas, 1 g of salt and 350 ml of warmed water (50 °C) were mixed with a wooden spoon and fermented in a jar in an oven at 40 °C for 16 hours [10]. The mixture obtained at the end of the fermentation was filtered to obtain chickpea yeast.

2.4 Bread kadayıf production

For the production of bread kadayıf, firstly the preliminary yeast was created and then the main dough mass was started. For the active dry yeast added sample, preliminary yeast was created using 16 g of flour, 6 g of active dry yeast and 70 ml of water and then left for 10 minutes. To create the main dough, 80 g eggs, 230 g flour, 100 ml water, 50 g butter and 1.5 g salt were added to the preliminary yeast and mixed in a mixer (Kitchen-aid, Artisan Series, Greenville, USA) until a homogeneous dough was obtained. The resulting dough was fermented at 30°C for 40 minutes, and then it was placed on a 30 cm diameter tray, kneaded with 30 g of oil and spread on the tray. The dough, which fermented for 30 minutes in the tray, was baked in a preheated oven (Bosch HGD52D120T, Istanbul, Turkey) at 200°C for 35 minutes. Before experimental evaluation, bread kadayıf samples were cooled for at least 1 hour. For the production of samples with wheat germ, 30% germ was used as a substitute for wheat flour. For the production of sourdough added samples, 92 g of sourdough was used instead of the preliminary yeast. For the production of chickpea yeast added samples, 70 ml of water in the preliminary yeast used in the active dry yeast added samples was replaced with 70 ml of chickpea yeast (filtrate) and the preliminary yeast was created with 22 g of flour (Table 1). As a result, bread kadayıf experiments were carried out with 3 different fermantation methods (FM), with and without wheat germ addition, in two replications (3x2)x2. Figure 1 exhibited the dry bread kadayıf produced with wheat germ and active dry yeast as a sample.

Figure 1. Dry bread kadayıf sample produced with wheat germ and active dry yeast

2.5 Physical and chemical properties

Color values (L^* value [(0) black-(100) white], a^* value [(+) red-(-) green] and b^* value [(+) yellow-(-) blue]) were determined using the Minolta CR-400 (Konica Minolta Sensing, Inc., Osaka, Japan) device.

Moisture, ash, crude protein and crude fat contents were determined according to AACC methods numbered 44-19, 08-01, 46-30 and 30-25 respectively [11].

In order to determine both the total phenolic content (TPC) and antioxidant activity, Wronkowska et al. [12]'s method has been modified. 1 g of the sample was shaken with 80% methanol water (10 ml) and centrifuged to obtain the supernatant.

Table 1. Ingredients of bread kadayıf samples

Bread Kadayıf Samples							
FM 1	Active dry yeast 92 g	wheat flour 230 g	-	egg 80 g	butter 50 g	oil 30 g	salt 1.5 g
FM 1	Active dry yeast 92 g	wheat flour 161 g	wheat germ 69 g	egg 80 g	butter 50 g	oil 30 g	salt 1.5 g
FM 2	Sourdough 92 g	wheat flour 230 g	-	egg 80 g	butter 50 g	oil 30 g	salt 1.5 g
FM 2	Sourdough 92 g	wheat flour 161 g	wheat germ 69 g	egg 80 g	butter 50 g	oil 30 g	salt 1.5 g
FM 3	Chickpea yeast 92 g	wheat flour 230 g	-	egg 80 g	butter 50 g	oil 30 g	salt 1.5 g
FM 3	Chickpea yeast 92 g	wheat flour 161 g	wheat germ 69 g	egg 80 g	butter 50 g	oil 30 g	salt 1.5 g

For TPC determination, 0.1 ml of the supernatant, 0.9 ml of distilled water, 1 ml of 10% diluted Folin-Ciocalteau reagent (Merck, Germany) and 2 ml of 10% sodium carbonate (Merck, Germany) solution were mixed. The mixtures were incubated for 1 hour at room temperature and in a place protected from light, and then the absorbance values were obtained on a spectrophotometer (Shimadzu UV-1800 UV / Visible Scanning Spectrophotometer; 115 VAC, US) at 765 nm. TPC is expressed in gallic acid equivalents.

2-2-Diphenyl-2-picrylhydrazyl (DPPH) method was used to determine the antioxidant activity of the samples. In analysis; 0.25 ml of DPPH solution and 2 ml of 80% methanol solution and 0.1 ml of extract were mixed and kept in a dark environment at room temperature for 20 minutes. At the end of the period, absorbance measurements of the samples were made on a spectrophotometer at 517 nm and the inhibition was calculated as the percentage.

To determine the amount of phytic acid in the samples, the method of Haug and Lantzsch [13] was used and colorimetric determination was made. For this purpose, the phytic acid in the samples was extracted with 0.2 N HCl and then ammonium iron (III) sulfate solution was added. The free iron in the serum was colored with bipyridine solution and the amount of phytic acid was determined by reading the absorbance value at 519 nm.

To determine the amounts of Ca, K, Fe and Zn elements in the samples, 1 g of dried sample was treated with sulfuric acid and kept for 24 hours. Then, the heated samples were bleached with hydrogen peroxide. The samples, diluted to 100 ml with pure water, were filtered and the mineral substance amounts were determined by Inductively Coupled Plasma Optical Emission Spectrometry (ICP–OES) (Agilent 720).

2.6 Sensory analyses

The bread kadayıfs produced in this study were equally sized (5x5 mm), soaked (100 ml water) and syruped (170 g sugar/200 ml water) for sensory evaluation and then samples encoded with three-digit numbers in random order were presented to the panelists. Sensory acceptability of samples was appraised by a trained panel of seven members. The samples were evaluated in terms of color, taste, odor, pore structure and overall acceptability. The evaluation was made using a scale between 1 and 7 (1: extremely bad, 2: very bad, 3: poor, 4: average, 5: good, 6: very good and 7: extremely good).

2.7 Statistical analysis

Statistical analysis with using JMP statistical program, version 5.0.1 (SAS Institute Inc., Cary, NC, USA) was applied to determine the differences between the analysis results of bread kadayıf samples. The data were subjected to analysis of variance, and mean comparison was conducted using Tukey HSD test for assessment effects of different fermantation methods (active dry yeast, sourdough and chickpea yeast) and mean comparison was performed using Student's t test for assessment of wheat germ effect. A significance level of 5% was accepted for all mean comparisons.

3 Results and discussions

3.1 Some physical and chemical properties of raw materials

Since the wheat flour used in the production of bread kadayıf is substituted with wheat germ, the physical and chemical analysis results of these raw materials were given in Table 2. *L**, *a** and *b** values of wheat flour and germ were 92.52, -0.40, 10.57 and 76.56, 1.50, 28.77 respectively. The color values of wheat flour are related to the flour yield obtained during the milling stage. It is also known that wheat variety and particle size are effective factors on flour color. As expected, wheat flour was found to have higher *L** and lower *a** and *b** values than wheat germ. Levent and Bilgiçli [14] produced cakes using coarse and fine wheat germ in their study and found the *L** values of wheat flour, coarse and fine wheat germ as; 94.8, 77.85 and 79.19, *a** values; 0.52, 1.59 and 1.12 and *b** values; 13.7, 29.09 and 28.01 respectively. On the other hand, when chemical content of raw materials is examined, it can be clearly said that wheat germ is superior to wheat flour. It has been reported in the literature that wheat germ contains three times more protein, seven times more fat and six times more minerals than wheat flour. It is also stated to be a rich source of vitamins, minerals, unsaturated fatty acids, free sugars and functional phytochemicals including ferulic acid, phytic acid, glutathione and phytosterols [15]. When ash, crude protein, crude fat contents of wheat flour were 0.46, 10.52, 1.34 g/100g respectively, these results were determined as 4.19, 26.32 and 11.20 g/100g for wheat germ.

Also, TPC, antioxidant activity and phytic acid values of the raw materials were significantly higher in wheat germ. The TPC, antioxidant activity and phytic acid values of wheat flour and wheat germ were 58.67 and 165.13 mg GAE/100g, 12.76% and 90.06% and 261.97 and 2127.24 mg/100g, respectively. Cankurtaran [16] drew attention to the phytic acid content of the parts removed by milling and stated that although the loss of phytic acid seems to be an advantage when it is considered as an antinutritional substance, it can be interpreted as a functional disadvantage

when the antioxidant property of phytic acid is taken into account. When the mineral content values of wheat germ and wheat flour were compared, it was seen that the mineral values of wheat germ had higher values than wheat flour. This is an expected result, as it is known that germ is a dense area in terms of mineral substances. Demirci [17] determined the Ca, Fe, K, P and Zn contents for wheat flour as 19.64, 1.53, 146.66, 209.99 and 1.38 mg/100g, while the amounts of the same minerals in wheat germ were 50.08, 10.37, 859.77, 924.36 and 14.72 mg/100g. The study stated that differences in the mineral content of both wheat flour and wheat germ may occur depending on the type of wheat from which they are obtained, the changes in the growing conditions of these wheat and the efficiency during the milling process.

Table 2. Physical and chemical properties of raw materials

	Wheat flour	Wheat germ
*L**	92.52±1.26a	76.56±1.94b
*a**	-0.40±0.06b	1.50±0.33a
*b**	10.57±0.09b	28.77±2.30a
Moisture (g/100g)	11.33±0.01a	8.71±0.11b
Ash (g/100g)	0.46±0.01b	4.19±0.21a
Crude protein(g/100g)	10.52±0.23b	26.32±0.62a
Crude fat (g/100g)	1.34±0.38b	11.20±0.40a
TPC (mg GAE/100 g)	58.67±0.78b	165.13±1.55a
AA(Inhibition %)	12.76±0.13b	90.06±2.05a
Phytic acid (mg/100g)	261.97±1.10b	2127.24±3.04a
Ca(mg/100g)	33.75±0.93b	59.37±0.47a
K (mg/100g)	166.15±1.54b	865.55±1.04a
Fe (mg/100g)	0.20±0.01b	5.85±0.08a
Zn (mg/100g)	0.79±0.01b	9.10±0.02a

Means with the same letter are not statistically different from each other ($p<0.05$). TPC: Total phenolic content AA: Antioxidant activity

3.2 *Color properties of bread kadayıf samples*

*L**, *a** and *b** values of crust and crumb color of bread kadayıf samples were presented in Table 3. When the crust color values of bread kadayıf samples were evaluated in terms of fermantation methods, it was seen that sourdough generally increased *L** and *b** values in both samples with and without germ, but the *a** value was not affected by the fermantation methods. The addition of germ only caused an increase in the *a** value in crust color, and the *L** and *b** values were not statistically affected by the addition of germ. Crust *L** and *b** values may vary depending on the content of the fermantation and also it is thought that wheat germ, which has high amino acid/sugar content, may have contributed to the Maillard reaction, causing the increament of a* value in kadayıf samples.

Crumb *L** values of kadayıf samples varied between 52.15-65.13, crumb *a** values varied between -1.69-2.08 and b* values varied between 20.21-26.40.

As in the crust *L** values, crumb *L** values increased in sourdough added samples both with and without germ, and the *a** value did not show a statistically significant difference with the change in fermantation methods. The addition of germ decreased the crumb *L** value, but had no significant ($p<0.05$) effect on the *b** value. Maybe it could be thought that sourdough could provide a higher crumb *L** value compared to active dry yeast and chickpea yeast as a result of feeding it only with wheat flour and water. On the other hand, it could be thought that the crust *a** value and crumb *L** value were affected by the addition of germ at the end of the baking process of the final product. Furthermore, the addition of germ might also mask the potential of color change of different fermantation methods in the final product.

Gómez et al. [18] produced bread with raw and processed wheat germ (0-10%) in their study and determined the *L**, *a** and *b** values of the samples without wheat germ as 58.96, 13.92 and 23.1, respectively, while these values were 49.89, 13.28 and 25.31 respectively in samples with 10% wheat germ added. They stated that wheat germ did not cause a significant change in color at the maximum rate expressed. In the study conducted by Yıldırım and Arıcı [19] the color characteristics of sourdough breads were monitored at different fermentation temperatures and it was stated that the most important difference was in the *a** values of the crust color.

3.3 *Chemical properties of bread kadayıf samples*

In order to determine the chemical composition of kadayıf samples, mineral content (Ca, K, Fe, Zn), TPC, antioxidant activity, phytic acid content as well as proximate analysis were investigated and the results were shown in Table 4, 5 and 6.

Table 3. Color properties of bread kadayıf samples

	L*		a*		b*	
	Without wheat germ	With wheat germ	Without wheat germ	With wheat germ	Without wheat germ	With wheat germ
Fermentation method	Crust color					
Active dry yeast	48.27±1.53Ba	41.37±1.72Ca	7.75±0.66Ab	13.64±0.21Aa	29.43±2.21Ba	29.41±0.37Ca
Sourdough	64.38±1.84Aa	62.09±0.18Aa	7.20±1.20Ab	11.38±0.74Aa	37.85±0.55Aa	40.15±0.52Aa
Chickpea yeast	59.76±0.50Aa	57.15±1.03Ba	6.88±1.51Ab	14.04±1.07Aa	33.87±1.07ABa	35.34±0.78Ba
	Crumb color					
Active dry yeast	59.83±0.35Ba	53.60±0.47Bb	-1.69±0.05Ab	0.33±0.44Aa	20.21±0.23Ba	22.01±2.47Aa
Sourdough	65.13±0.49Aa	60.81±1.20Ab	0.69±1.22Aa	0.92±0.29Aa	25.73±2.06Aa	25.52±0.35Aa
Chickpea yeast	59.73±0.83Ba	52.15±0.91Bb	-0.33±0.04Ab	2.08±0.88Aa	23.47±0.15ABa	26.40±1.11Aa

Values followed by different lowercase letters within each row (indicating differences among average of bread kadayıf samples without or with wheat germ) and by different uppercase letters within each column (indicating differences among average of bread kadayıf samples with different fermentation methods) are significantly different at $p<0.05$.

Moisture content of samples were obtained in the range of 40.01-43.78 g/100g (Table 4) and these values were statistically similar to each other. On the other hand, the higher ash, protein and fat contents of wheat germ compared to wheat flour were reflected in the ash, protein and fat contents of the kadayıf samples. The ash, protein and fat contents ranged from 0.92, 10.65, 15.18 g/100g to 1.65, 14.73 and 18.60 g/100g respectively (Table 4). The different fermantation methods did not have statistically significant effect on the protein and fat contents but the ash content increased with chickpea yeast. It can be thought that the higher ash content of samples with chickpea yeast is due to the existing mineral content in the structure of chickpeas passes into the filtrate during the production of chickpea yeast.

TPC and antioxidant activity increased with wheat germ and chickpea yeast addition (Table 5). TPC values were between 31.26 and 42.28 mg GAE/100 g for samples without wheat germ and were between 56.56 and 82.77 mg GAE/100 g for samples with wheat germ. The antioxidant activity values increased more than three times thanks to the addition of wheat germ and the values varied between 7.99-36.15 %. The general opinion in the literature is that phenolic compounds in grains decrease as a result of thermal processes such as cooking. However, recent researches have found that cooking increases total phenolic acid and ferulic acid levels due to intense heat, which makes some phenolic compounds more bioaccessible. Furthermore, it has been reported that the bioaccessibility of phenolic acids increases with fermentation application. It has been stated that enzymes produced by microorganisms during fermentation have the potential to release bound polyphenols and thus increase their bioaccessibility [20, 21]. On the other hand, it has been stated that different bacteria isolated from sourdough develop cellular defense by synthesizing antioxidant enzymes and develop protective properties against harmful radicals by synthesizing antioxidant exopolysaccharides [22]. The microorganism content, which differs with the use of chickpea yeast, and high phenolic content and antioxidant substance potential of chickpeas that will be able to pass into chickpea yeast may be increased the TPC and antioxidant activity in the samples compared to active dry yeast and sourdough fermentation. Liu et al. [23] investigated the phenolic content of fermented wheat germ for increasing time (12-72 hours) and reported that the TPC of fermented germ samples increased with increasing fermentation time. Mahmoud et al. [24] investigated the antioxidant properties of skimmed wheat germ in their study to transform wheat germ into a value-added product and stated that the reducing power of skimmed wheat germ extract against DPPH and ABTS radicals is as effective as BHA (butylated hydroxyanisole) and BHT (butylated hydroxytoluene).

Phytic acid content of samples increased with wheat germ and also phytic acid content of sourdough and chickpea yeast-added bread kadayıf samples were obtained close to each other for samples without and with wheat germ. The highest values were observed in kadayıf samples with active dry yeast (215.71-715.30 mg/100 g).

Table 4. Proximate analysis of bread kadayıf samples

	Moisture (%)		Ash (%)		Protein (%)		Fat (%)	
	Without wheat germ	With wheat germ	Without wheat germ	With Wheat germ	Without wheat germ	With wheat germ	Without wheat germ	With wheat germ
Fermentation method								
Active dry yeast	43.25±1.56Aa	42.73±1.54Aa	0.92±0.01Bb	1.52±0.02Ba	10.65±0.54Ab	13.01±0.19Aa	15.73±0.09Ab	17.63±1.21Aa
Sourdough	40.01±0.54Aa	41.17±0.84Aa	0.93±0.01Bb	1.53±0.01Ba	11.06±0.15Ab	12.89±0.56Aa	15.68±0.37Ab	18.21±0.28Aa
Chickpea yeast	42.22±0.74Aa	43.78±0.42Aa	1.17±0.01Ab	1.65±0.01Aa	11.95±0.45Ab	14.73±0.99Aa	15.18±0.13Ab	18.60±0.33Aa

Values followed by different lowercase letters within each row (indicating differences among average of bread kadayıf samples without or with wheat germ) and by different uppercase letters within each column (indicating differences among average of bread kadayıf samples with different fermentation methods) are significantly different at $p<0.05$.

Table 5. Chemical properties of bread kadayıf samples

	Total phenolic content (mg GAE/100 g)		Antioxidant activity (Inhibition %)		Phytic acid (mg/100g)	
	Without wheat germ	With wheat germ	Without wheat germ	With wheat germ	Without wheat germ	With wheat germ
Fermentation method						
Active dry yeast	31.26±1.16Bb	56.56±1.73Ba	8.22±0.67Bb	28.45±0.67Ba	215.71±5.20Ab	715.30±4.10Aa
Sourdough	38.18±2.46Bb	68.00±3.46Ba	7.99±0.20Bb	29.78±0.66Ba	133.81±3.70Bb	579.90±5.52Ba
Chickpea yeast	42.28±1.18Ab	82.77±3.88Aa	11.63±0.94Ab	36.15±0.60Aa	122.71±1.66Bb	556.50±6.91Ba

Values followed by different lowercase letters within each row (indicating differences among average of bread kadayıf samples without or with wheat germ) and by different uppercase letters within each column (indicating differences among average of bread kadayıf samples with different fermentation methods) are significantly different at $p<0.05$.

It is stated that wild yeast and lactobacilli present in sourdough neutralize phytic acid and facilitate the digestion of products. Sourdough fermentation is much more effective than yeast fermentation in reducing phytate content. By breaking down the phytate structure, the absorption of important minerals such as iron, zinc, magnesium found in sourdough bread increases [22]. Didar [25] reported that the phytic acid content decreased with the addition of more sourdough in pitas which containing different bacterial strains. Lopez et al. [26] compared the effect of yeast fermentation, sourdough fermentation and a mixture of the these on the breakdown of phytic acid in their bread study. The results showed that the phytic acid content in breads produced by sourdough fermentation was reduced by up to 62%, whereas conventional yeast fermentation reduced it by only 38%.

Considering the mineral values of the samples, results were determined between 43.16-58.04 mg/100g for Ca, 190.93-397.95 mg/100g for K, 0.54-3.53 mg/100g for Fe and 0.97-2.87 mg/100g for Zn (Table 6). As expected, the addition of wheat germ occurred an increase in the mineral values of bread kadayıf samples. Sidhu et al. [27] reported that as a result of adding 10% and 20% germ to the bread formulation, the mineral content of bread samples increased significantly compared to the control, and this may be due to the fact that wheat germ has a rich content in minerals. On the other hand, Zn content was found to be higher in samples with active dry yeast and K content was found to be lower in samples with sourdough. The use of chickpea yeast increased the Ca and Fe contents. Hendek Ertop and Coşkun [28] investigated the possibilities of using dried chickpea sourdough in bread production and observed that the mineral content increased with the use of chickpea sourdough. They reported that this may be related to the content of chickpeas used in sourdough because chickpeas contain an average of 3% ash, 0.2% calcium and 0.3% phosphorus and are a rich source of minerals (Ca, P, Fe, Mg, K).

3.4 Sensorial properties of bread kadayıf samples

The results obtained in the sensory analysis of bread kadayıfs produced without and with wheat germ were shown in Figure 2. First of all, it should be noted that the addition of wheat germ did not create a statistically significant difference in all results compiled in the sensory analysis (data not shown). Therefore, this study showed that germ could be used up to 30% in the bread kadayıf formulation. The color scores of the samples varied between 4.20 and 6.00 and when examined in terms of fermantation methods, results in samples without wheat germ addition were not statistically different from each other. However, the use of sourdough resulted in lower color scores compared to the use of active dry yeast in samples with added wheat germ. Taste scores were higher in samples with active dry yeast (5.60-5.12) and the lowest scores in taste scoring were obtained with the use of chickpea yeast (3.04-2.78). Although it was observed that the odor scores decreased with the use of sourdough and chickpea yeast, it was determined that the method of fermantation did not create a statistically significant difference. When we look at the pore structure results, the samples made using active dry yeast without wheat germ (6.80) and with wheat germ (6.00) received the highest scores. While the samples with chickpea yeast received the lowest scores (3.00) in the samples without germ, there was no significant difference with the use of sourdough and chickpea yeast in the samples with germ. The bread kadayıf samples with active dry yeast (6.00-5.00) received the highest overall acceptability scores. In samples without germ, the use of sourdough and chickpea yeast, respectively, decreased the overall acceptability scores (4.50, 2.70). In the samples with wheat germ, the lowest overall acceptability scores were obtained with the use of chickpea yeast (3.38). Emirli [29] produced sourdough bread with 30% germ and the samples were compared with sensory analysis, scoring in the range of 1-5. Wheat breads was more appreciated than germ breads in terms of taste, crumb color and general appreciation, and both types of breads were evaluated with a score above 3. Rizzello et al. [30] used wheat germ fermented with sourdough in the production of wheat bread to improve its nutritional, texture and sensory properties. Considering the sensory analysis results, they found that the highest color and taste values (5.90 and 6.80 respectively) were seen in the bread with fermented wheat germ, followed by raw wheat germ bread (5.70 and 6.30) and control bread (2.90 and 5.30).

Table 6. Mineral content of bread kadayıf samples

	Ca		K		Fe		Zn	
	Without wheat germ	With wheat germ	Without wheat germ	With wheat germ	Without wheat germ	With wheat germ	Without wheat germ	With wheat germ
Fermentation method								
Active dry yeast	45.02±0.69Bb	49.20±0.40Ba	228.53±2.17Bb	397.95±2.37Aa	0.54±0.01Cb	1.63±0.01Ca	1.14±0.03Ab	2.87±0.01Aa
Sourdough	43.16±0.99Bb	49.70±0.09Ba	190.93±2.68Cb	359.86±1.96Ca	0.68±0.01Bb	2.32±0.04Ba	0.99±0.01Bb	2.50±0.03Ba
Chickpea yeast	50.77±0.41Ab	58.04±0.68Aa	252.16±1.07Ab	370.92±0.56Ba	1.92±0.01Ab	3.53±0.03Aa	0.97±0.01Bb	2.51±0.02Ba

Values followed by different lowercase letters within each row (indicating differences among average of bread kadayıf samples without or with wheat germ) and by different uppercase letters within each column (indicating differences among average of bread kadayıf samples with different fermentation methods) are significantly different at $p<0.05$

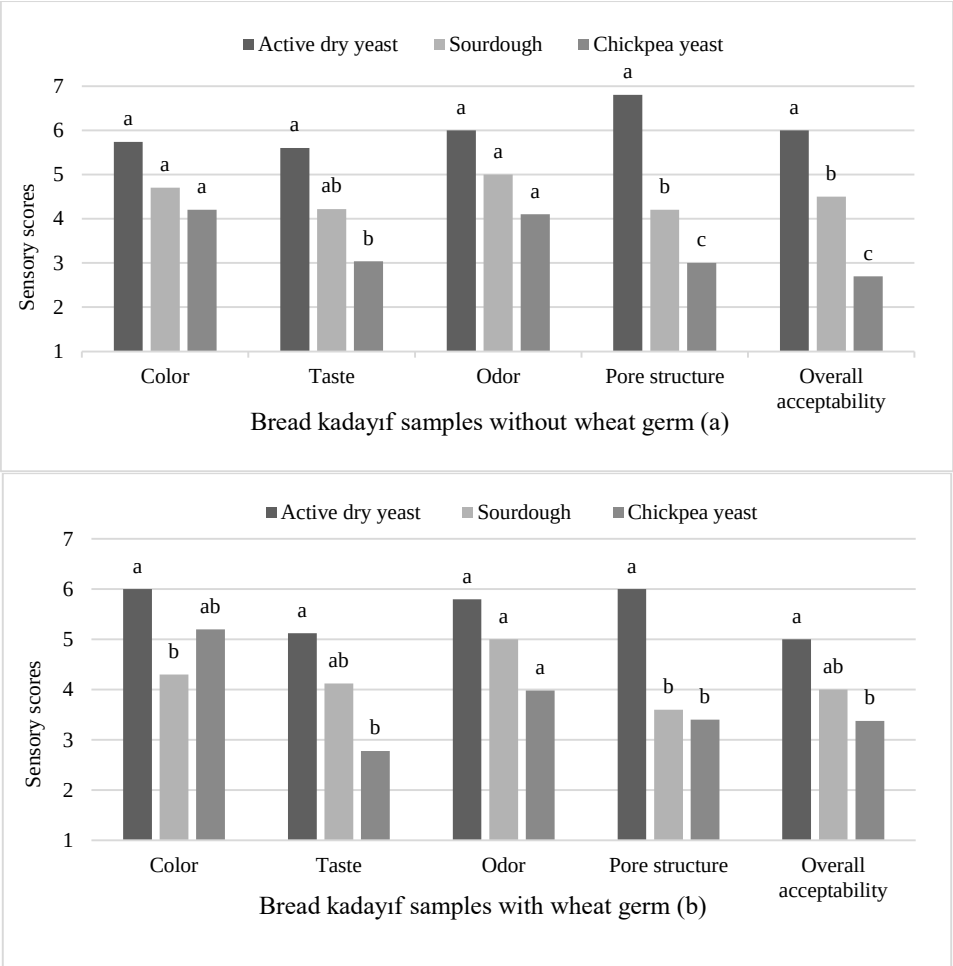

Figure 2. Sensorial properties of bread kadayıf samples a) without wheat germ b) with wheat germ (Values followed by different lowercase letters are significantly different at $p<0.05$.)

4 Conclusions

This study demonstrated that wheat germ can be used up to 30% in bread kadayıf without negative sensory effects and chickpea yeast may enhance nutritional properties but did not create sufficient taste. The study provides valuable data for different functional bread kadayıf studies and future studies should investigate the long-term storage stability of bread kadayıf with different fermentation types and wheat germ. Wheat germ using with various stabilization techniques and more controlled conditions with different pure cultures to support fermentation should be examined.

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Conflict of interest

The authors declare that there is no conflict of interest.

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