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Use of Ancient Wheat (Einkorn and Emmer) to Improve the Nutritional and Functional Properties of Gevreks

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ABSTRACT: The aim of this study is to determine the suitability of ancient wheat (einkorn and emmer) flours to increase functional properties such as phenolic content and antioxidant activity of gevreks. The einkorn and emmer wheat flour was replaced up to 100% ratio with refined wheat flour in gevrek formulation. Experiments were conducted according to (2×5)×2 factorial design. Some physical, chemical, functional and sensory properties of those gevreks were determined and compared with control gevreks prepared with wheat flour. Einkorn flour usage gave higher lightness and lower redness to gevrek samples compared to emmer flour. Also, gevrek containing emmer had the lowest width (17.13 mm) and hardness (3398.59 g) as well as similar thickness and fracturability to gevrek containing einkorn. Increasing the ancient wheat flour ratio markedly improved all of the measured chemical and nutritional properties of the gevrek samples. Among the ancient wheat flours, emmer flour revealed a higher fat, antioxidant activity (DPPH, FRAP and CUPRAC) value and phenolic content than einkorn flour in gevreks. With the addition of einkorn flour, richer Ca, Fe and Mg contents were obtained in gevrek samples. It has been determined that the sensory properties of the gevreks produced with the addition of einkorn provide more acceptable products.

Keywords: Ancient wheat, einkorn, emmer, gevrek.

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INTRODUCTION

Depending on the changing lifestyle in the world, interest in fast consumption snacks containing high carbohydrates, fats and sugars has increased in the last 20 years (Akbay ve et al., 2007). In Turkey, "fast consumption" products are classified as french fries, toast and pastry (Anonymous, 2014), and gevrek, which are among the "traditional flavors" of our country, are included in this group (Turgut et al., 2015). Gevrek; is one of the oldest snack products such as cakes, biscuits, crackers, and is a grain-based snack traditionally produced in Turkey and different parts of the world. Although its formulation varies according to the region where it is produced. The history of gevrek goes thousands of years ago. It is a type of food prepared for a child going to the military. It has a delicious taste because it is prepared with flour, milk, butter sugar, yeast, salt, sesame, milk, yogurt and eggs and it is cooked in a tandoor, it becomes crispy and disperses in the mouth as soon as it is chewed (Tugay et al., 2004).

Einkorn (Triticum monococcum L.) is a diploid (2n = 2x = 14) hulled wheat and has been the staple food of humanity for thousands of years, today it is cultivated only in small regions of Turkey and continental Europe (Hidalgo and Brandolini, 2014). In many scientific studies, it has been determined that einkorn wheat has more protein, fat, carotenoid and lutein amounts than bread wheat. It has been observed that the hull structure is very hard and difficult to separate, and thanks to its single spikelet structure, it is more resistant to adverse weather conditions, harmful insects and diseases (Abdel-Aal et al., 2007). In the study by Hidalgo and Brandolini (2014), it was determined the einkorn wheat is richer in minerals, carotenoids, tocols, phenolics, alkyl resorcinols and phytosterols compared to durum and bread wheat and on average, It contains 2.7% sugar, 6.5% starch, 3.5% fat, 1.2% dietary fiber, 1% β-glucan. Einkorn is traditionally used in the production of einkorn bulgur, bread, tarhana and simit in Turkey.

Emmer (Triticum dicoccum) is an ancient type of wheat cultivated in Anatolia for centuries. It is mostly grown around Kars province and is known as Kavılca, Kabluca, Yaban wheat. Today, emmer wheat is cultivated by 400 farmers in 12 provinces and around 600 tons are produced. It is traditionally consumed by adding it to bulgur, cabbage rolls, noodles, pastries and bread formulations (Zengin, 2015). Considering their superior adaptability, emmer wheat has a high yield compared to modern wheat is mostly in mountainous areas and regions where difficult environmental conditions (Atak, 2017). It is stated that emmer wheat is rich in dietary fiber, resistant starch, carotenoids and antioxidant compounds (Fares et al., 2008). This study aimed to investigate the effects of ancient wheat on the nutritional and functional properties of gevreks.

MATERIALS AND METHODS

Materials

Wheat flour (Type 550) used to prepare in the gevreks production was supplied from a flour mill factory (Meram Un San. AŞ.) in Tukey. Fresh yeast (*Saccharomyces cerevisiae)*, sugar, table salt, all-purpose shortening and sunflower oil were purchased from local markets in Konya. Einkorn and Emmer wheat were obtained from Kastamonu and Kars, Turkey, respectively. Einkorn and emmer wheat were ground (<500 µm) in a kitchen grinder (Arsel Kitchen Grinder Mill, Turkey) to obtain whole einkorn and emmer flour.

Methods

Preparation of yağlı gevreks

Gevrek samples were prepared using the traditional yağlı gevrek metod. To prepare the gevrek sample; wheat flour (200.0 g), sugar (8.0 g), salt (4.0 g), all-purpose shortening (66.4 g), sunflower oil (20 g) and baker's yeast (1.6 g) were used. The recipe used for gevreks is presented in Table 1. All components were kneaded in a kneader (Kenwood KMX750RD, Hampshire, UK), for 8 minutes with 20 ml of water until a homogeneous dough was obtained and the dough was covered with a damp cloth and left to ferment for 20 minutes at room temperature. At the end of the period, the dough obtained was divided into 80 gr pieces and thinned to 1.5 cm in height between two glass plates. Afterward, the doughs were cut 2 cm wide and 10 cm in length and given their final shape. The gevreks were baked in the oven (Fimak Rokon Classic FRN10 G, Konya, Turkey) for 10 minutes at 230 °C and then cooled to room temperature (18–20 °C) for analysis (Figure 1).

Table 1. Formulation of control gevrek

Ingredients	% (Wet basis. w/w)
Wheat flour	100
Sugar	4
Table salt (NaCl)	2
All-purpose shortening	33.2
Sunflower oil	10
Baker's yeast	0.8
Water	10

Physical properties

Color measurements of gevreks were carried out on five different points on the surface of samples using a Hunter colorimeter (Minolta Chroma Meter CR-400, Osaka, Japan). Color values of gevreks were recorded as "L*" (lightness), "a*" (redness) and "b*" (yellowness). Saturation Index ($[a^{*2} + b^{*2}]^{1/2}$) and hue angle (hue angle = arctan [b*/a*]) of the gevrek samples were calculated.

Width and thickness were measured with a digital micrometer (0.001 mm, Mitutoyo, Minoto-Ku, Tokyo, Japan) at five different places in each gevreks and the average was calculated for each.

Texture Analyzer (TA-XT plus, Stable Microsystems, UK) was used to measure the hardness and fracturability of gevrek samples via 3-point bending test using 3-point bending rig. Test condition, load cell: 5 kg, pre-test speed: 1.0 mm/s, post-test speed: 10.0 mm/s, distance: 3.0 mm, trigger force: 50 g.

Chemical analysis

Moisture, ash, protein and fat contents of wheat flour, whole einkorn flour, whole emmer flour and gevreks were analyzed by using standard methods (AACC, 2000). Phytic acid was measured colorimetrically using the method given by Haug and Lantzsch (1983). The phytic acid in the sample was precipitated with Fe III solution after extraction with the hydrochloric acid solution. The amount of iron remaining in the extract was determined by reading with a spectrophotometric (Hitachi-U1800, Japonya) at 519 nm, and the amount of phytic acid was calculated.

Antioxidant capacity

Einkorn and emmer wheat samples were milled to a particle size of less than 0.5 mm and extracted as described before for antioxidant capacity analysis. The extraction was carried out with 80% methanol. Three different methods were used to determine the antioxidant capacity of the samples.

Figure 1. Gevrek samples prepared using einkorn and emmer wheat flour

Analysis of DPPH radical scavenging capacity; The DPPH radical scavenging capacity of raw materials and gevrek samples was determined according to the method of Gyamfi et al. (1999) and Beta et al. (2005) with slight changes. Every sample extract (0.1 ml) was added to 3.9 ml of 6×10^{-5} mol/L methanolic solution of DPPH. The absorbance at 517 nm was measured with a spectrophotometer (Hitachi-U1800, Japonya) after the solution had been allowed to stand in the dark for 30 min. Lower absorbance of the reaction mixture indicates higher free radical scavenging activity. The Trolox calibration curve was plotted as a function of the percentage of DPPH radical scavenging activity. The final results were expressed as micromoles of Trolox equivalents (TE) per gram of dry matter (mg TE/kg dm) ($y=0.0065x+ 0.9838$, $R^2 = 0.9988$).

Analysis of ferric reducing antioxidant power; The ferric reducing antioxidant power assay (FRAP) of raw materials and gevrek samples was determined according to the method of (Yılmaz, 2019). The 50 µL of germinated wheat flour extract was mixed with 700 µL of the FRAP reagent and after 5 min of incubation at 37°C, absorption was measured at 593 using a spectrophotometer (Hitachi-U1800, Japonya). Methanolic solutions of known Trolox concentration are used for calibration of the FRAP assay. FRAP values, expressed as mmol of Trolox equivalent per g dry matter ($y=0.0078x+0.0737$, $R^2 = 0.9982$).

Analysis of cupric reducing antioxidant capacity; Cupric ion reducing antioxidant capacity (CUPRAC) of the extract was determined according to the method of Apak et al. (2008). The mixture of 1 mL of 10 mM $CuCl_2$ solution, 7.5 mM neocuproine alcoholic solution and 1 M ammonium acetate (pH 7.0) buffer solution, the extract (x mL) and H_2O [$(1.1-x)$mL] were added to make the final volume of 4.1mL. The Mixture 5 min of incubation at 37°C, and absorption was measured at 450 using a spectrophotometer (Hitachi-U1800, Japonya). Using Trolox as standard the antioxidant capacity (FRAP) was expressed as (µmol TE/g) of sample ($y=0.0108x+0.0519$, $R^2 = 0.9987$).

Phenolic content

Free and bound phenolic content was extracted according to the method specified by Vitali et al. (2009) with minor modifications. For free phenolics, 2 g of the sample was shaken (Daihan Wisebath WSB-30, Gangwon, South Korea) with 20 ml of HCl/methanol/water (1:80:10,v/v) mixture at 50 rpm for 2 hours at 20°C. The mixture was then centrifuged at 3500g for 10 minutes at 4°C in a centrifuge (Hermle Z 326 K, Wehingen, Almanya) and the supernatant was stored at -20°C for analysis. For the bound phenolic content, 20 ml of methanol/H_2SO_4 (10:1) was added to the residue remaining after free phenolic extraction, incubated in a water bath at 85°C for 20 hours and then cooled at room temperature. As with free phenolic analysis, the mixture was centrifuged (3500g, 10 minutes at 4°C) and the supernatant was stored at -20°C for analysis.

The free and bound phenolic content of each extract was determined according to the Folin-Ciocalteu colorimetric method as performed by Naczk and Shahidi (2004). Total phenolic content was obtained by summing the free and bound phenolic content. Gallic acid was used as a standard and results were expressed in g of gallic acid equivalents (mg of GAE kg^{-1}) of gevrek sample on a dry matter basis (for free phenolic y=0.0014x-0.1072, R^2 = 0.9965 and bound phenolic y=0.0012x+0.0662, R^2 = 0.9976).

Mineral content

Mineral contents were determined according to the method given by Fingerová and Koplík (1999) with slight modifications. Content of minerals (Ca, Fe, Mg, K, P and Zn) were determined by inductively coupled plasma-mass spectrometry (ICP – MS) (Agilent Technologies - 7900 ICP-MS / ASX 500, Waldbronn, Germany). 1 g of each sample was dissolved in 7 ml of 65% HNO_3 + 30% H_2O_2 and a microwave oven (MARS 5, CEM Corporation, USA) was used for digestion. The concentrations of minerals in the decomposed samples were determined by ICP-MS.

Sensory analyses

The sensory properties of the crispy samples were scored in terms of color, appearance, taste, odor, fragility and general acceptability by 12 panelists from the Department of Food Engineering at Necmettin Erbakan University using a 7-point hedonic scale (7 = I liked it very much, 1 = I did not like it at all).

Statistical analyses

Statistical analysis was carried out using the JMP statistical program, version 22.0 (SAS Institute Inc., Cary, NC, USA). The data were analyzed using Analysis of Variance (ANOVA). The mean values were compared at the significance levels of 0.05 ($p < 0.05$).

RESULTS AND DISCUSSION

Color Properties of Gevrek Samples

The color values of gevrek samples are shown in Table 2. Ancient wheat flour types significantly ($p<0.05$) affected *L** and *a** color value of gevrek samples. Gevrek samples prepared with emmer flour showed darker and reddish color than that containing einkorn flour. This suggests that einkorn is less subject to heat damage during cooking, as low α- and β-amylase activity limits the degradation of starch. As a result, the reduced generation of reducing sugars in the dough limited the Maillard reactions during food processing (Brandolini and Hidalgo 2011). Flour types did not change the *b** and SI values of the gevrek samples significantly. The *b** and SI values of the einkorn and emmer flour added gevrek samples changed between 28.43 and 28.60; 29.72 and 30.11, respectively. Generally, an increase in the einkorn and emmer flour ratio in gevrek formulation resulted in a decrease in the lightness and Hue values, while the produced gevreks were determined to be more reddish and yellowish. Many factors may have contributed to this result. [1]This can be related to the raw material's color properties. Emmer wheat is known to have a reddish-brown color (Yılmaz, 2020), while einkorn wheat has been reported to be more yellowish due to its high lutein content (Abdel-Aal et al., 2017). [2]That ancient wheat was used in the form of whole flour, which contains the bran layer, in which the color pigments are intense. [3]The dark and red color of samples containing ancient wheat flour may be the result of non-enzymatic browning reactions such as Maillard and caramelization (Pınarlı et al., 2004). The Maillard reaction takes place where reducing sugars and proteins or their hydrolytic products are heated together, while caramelization is a term for describing a complex group of reactions that occur due to direct heating of carbohydrates, in particular, sucrose and reducing sugars (Fennema, 1996). In fact, browning reactions mainly depend on product formulation (amino compounds, sugars and leavening agents) and operating conditions (temperature, water activity, initial pH fermentation condition and time). Researchers have reported that the reducing sugar content of einkorn and emmer wheat is low (Hidalgo and Brandolini,2013; Dhanavath and Prasada,2017), however, studies have shown that the addition of yeast and the fermentation step increases the rate of non-enzymatic browning reactions in bakery products. [4]Due to the use of ancient wheat in the form of whole flour, the high phenolic component content may have been effective in the darker color of the final product. Similar changes in color properties with the use of emmer and einkorn flour have been reported by Yılmaz (2020) for bulgur, by Nakov et al. (2018) for cookies, for bread and noodle by Cankurtaran Kömürcü (2021) respectively. Goffman and Bergman (2004) stated that dark rice bran has higher phenolic content, while Cankurtaran Kömürcü (2021) reported that noodles prepared with primitive wheat with high phenolic content are darker in color than noodles prepared with modern wheat.

Table 2. Color properties gevrek samples

	n	*L**	*a**	*b**	Hue	SI
Flour types						
Einkorn	10	57.99±4.48a	8.17±0.87b	28.43±1.05a	74.04±1.37a	29.72±1.18a
Emmer	10	55.13±5.55b	9.42±1.11a	28.60±1.20a	72.14±2.22b	30.11±1.51a
Flour ratio (%)						
0	4	63.42±0.12a	7.44±0.19d	26.91±0.31d	75.48±1.44a	28.21±0.69c
25	4	59.73±1.61b	8.33±0.91c	27.89±0.40c	73.38±1.80ab	29.13±0.81bc
50	4	56.89±2.70c	8.93±1.19b	28.75±0.18b	72.77±2.11b	30.12±1.01ab
75	4	51.94±1.89d	9.46±0.39a	29.08±0.15b	72.49±0.99b	30.71±0.25ab
100	4	50.84±2.02e	9.82±1.17a	29.95±0.41a	71.34±1.82b	31.42±0.70a

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

Physical Properties of Gevrek Samples

The width, thickness, hardness and fracturability value of gevrek samples are presented in Table 3. The usage of einkorn in gevrek production resulted in higher width and hardness value in comparison to emmer flour. The use of einkorn and emmer flour types and ratios did not change fracturability significantly. An increase in the amount of ancient wheat flour in gevrek formulations caused a decrease in width and hardness value. The width and hardness values of gevrek samples ranged between 17.80 mm and 16.82 mm and between 4360.22 g and 2570.29 g, respectively. This may be related to the dilution of the gluten content that is available to connect the water and the weak gluten structures of ancient wheat. Moiraghi et al., (2011) reported the dependence of cookie -like products hardness on protein and gluten. The results indicated that the flours with lower gluten strength resulted into these products with softer texture. Textural quality (hardness and fracturability) is an important quality evaluation criterion for biscuits and similar products. In addition to the baking conditions, it has been reported that the type of flour used, the amount of ingredients and protein content affect its hardness and other textural properties (Adeola and Ohizua, 2018). Lauková et al. (2019) reported that the hardness value of crackers (1952.39 to 1068.73 g) and cookies (from 1748.41 to 1348.57 g) was reduced by the addition of sweet potato powder.

Table 3. Physical and texture properties gevrek samples

	n	Width (mm)	Thickness (mm)	Hardness (g)	Fracturability (mm)
Flour types					
Einkorn	10	17.65±0.40a	15.62±1.05a	3824.18±373.62a	44.75±0.58a
Emmer	10	17.13±0.57b	16.62±1.25a	3398.59±822.31b	44.630.34a
Flour ratio (%)					
0	4	17.80±0.26a	16.86±0.36a	4360.22±256.20a	44.49±0.40a
25	4	17.75±0.31a	17.05±0.74a	3953.30±64.51a	44.53±0.02a
50	4	17.68±0.43a	16.60±1.02a	3702.04±141.48b	44.57±0.03a
75	4	17.00±050b	15.34±0.45b	3471.09±155.21c	44.73±0.06a
100	4	16.82±0.48b	14.69±1.31b	2594.14±883.04d	45.15±0.85a

[1]Means followed by the same letter within a column are not significantly different (p<0.05).

Chemical Properties of Gevrek Samples

The moisture, ash, protein, fat and phytic acid content of gevrek samples are given in Table 4. Moisture, ash and protein content of gevrek samples did not change according to flour type factor. Table 4 shows that the fat and phytic acid content of gevrek samples prepared with emmer flour are higher than samples with einkorn. Increasing the use of ancient wheat flour in the cereal formulation significantly ($p < 0.05$) increased the ash, protein, fat and phytic acid content. This increase was significantly ($p<0.05$) higher in ash and phytic acid content compared to samples without ancient wheat flour at all addition ratios. This can be attributed to the rich ash and phytic acid contents of whole wheat flours of ancient wheat. Cubadda and Marconi (1996) reported a higher presence of phytic acid in einkorn than bread wheat flour. In addition, Cankurtaran Kömürcü (2021) stated that emmer has a higher phytic acid content than einkorn. Phytic acid is mainly concentrated in the bran layers of the grain and its amount decreases from outside to inside (Stevenson et al., 2012). Although phytic acid is an anti-nutritional component that prevents its absorption by forming chelates with minerals such as Ca, Fe, Zn, Mg and Cu, recent studies have suggested that it may have antioxidant activity (Cankurtaran and Bilgiçli, 2019). These results are similar to the observed increase in ash, protein and fat content of noodles and bread with the addition of ancient wheat flour (Cankurtaran Kömürcü, 2021), ash, protein and fat content of pasta enriched with einkorn (Hidalgo et al., 2020).

Table 4. Chemical properties gevrek samples

	n	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Phytic acid (mg 100 g^{-1})
Flour types						
Einkorn	10	5.97±0.80a	2.10±0.49a	10.31±0.77a	24.01±0.56b	435.28±392.72b
Emmer	10	5.81±0.95a	2.19±0.54a	10.36±0.71a	24.40±0.77a	842.53±430.69a
Flour ratio (%)						
0	4	7.02±0.28a	1.51±0.06e	9.41±0.25c	23.42±0.19d	165.84±19.72e
25	4	6.14±0.58b	1.78±0.08d	9.98±0.34bc	23.72±0.20d	592.85±71.05d
50	4	5.99±0.61b	2.10±0.10c	10.48±0.29ab	24.18±0.40c	809.62±97.11c
75	4	5.44±0.23bc	2.50±0.15b	10.79±0.75a	24.60±0.44b	1119.10±103.09b
100	4	4.84±0.53c	2.84±0.21a	11.03±0.47a	25.12±0.29a	1257.09±76.00a

[1]Means followed by the same letter within a column are not significantly different (p<0.05).

Antioxidant capacity and phenolic content of gevreks supplemented with ancient wheat flour are given in Table 5. Gevrek formulated using emmer resulted in higher DPPH, FRAP and CUPRAC antioxidant capacity and bound and total phenolic content than that of einkorn. The results obtained may be related to the fact that emmer wheat is rich in bioactive components. Cankurtaran Kömürcü (2021) reported that the antioxidant activity values and total phenolic content of emmer wheat were higher than that of einkorn wheat. The DPPH, FRAP and CUPRAC values recorded with ancient wheat flour (100%) were 542.17 mg TE kg^{-1}, 5.12 µmol TE g^{-1} and 7.67 µmo TE g^{-1} whereas the control value was recorded as 202.59 mg TE/kg^{-1}, 2.01 µmo TE/ g^{-1} and 3.56 µmoTE/ g^{-1}. Increasing ratio of einkorn and emmer wheat flour had a positive effect on the free, bound and total phenolics content of gevrek samples. As shown in Table 4, the high phenolic content may be responsible 1546ort he high antioxidant activity of the gevrek samples. The gevrek samples that did not contain ancient wheat flour were found to have lower free, bound and total phenolic content (2007.17, 2786.88 and 5098.07 mg GAE kg^{-1}) than the gevrek samples produced by adding different amounts of ancient wheat flour. This could probably ancient whole wheat flours have a higher phenolic content than refined wheat flour. The outer layers of the wheat are responsible for approximately 83% of the total phenolic content of whole wheat flour. Both the total phenolic content and antioxidant activity decrease gradually from the outer layer to the inner layer (Adom et al., 2005; Laddomada et al., 2015).

Table 5. Antioxidant activity and free, bound and total phenolic content of the gevrek samples[1]

	n	DPPH (mg TE kg^{-1})	FRAP (umol TE g^{-1})	CUPRAC (umol TE g^{-1})	FPC (mg GAE kg^{-1})	BPC (mg GAE kg^{-1})	TPC (mg GAE kg^{-1})
Flour types							
Einkorn	10	368.40±110.26b	3.50±1.01b	5.84±1.36b	2191.31±236.60a	3327.47±506.02b	5469.18±286.74b
Emmer	10	414.33±144.83a	4.19±1.41a	6.38±1.71a	2312.05±244.72a	4061.95±873.13a	6561.00±819.47a
Flour ratio (%)							
0	4	202.59±11.13c	2.01±0.29d	3.56±0.12d	2007.17±236.79b	2786.88±199.72b	5098.07±118.81b
25	4	347.92±30.62b	3.53±0.55c	5.86±0.13c	2196.22±340.55ab	3498.93±920.66ab	5992.79±831.73a
50	4	373.97±30.56b	3.91±0.55bc	6.46±042bc	2279.04±85.14ab	3913.58±618.98a	6146.59±856.36a
75	4	490.14±62.39a	4.65±1.01ab	7.01±0.85ab	2355.98±141.78a	4037.45±655.82a	6336.73±801.91a
100	4	542.17±57.16a	5.12±0.62a	7.67±0.78a	2419.99±188.20a	4236.71±701.03a	6501.30±753.37a

[1]Means followed by the same letter within a column are not significantly different ($p<0.05$). DPPH; 2,2- diphenyl-1-picrylhydrazyl, FRAP; Ferric reducing antioxidant potential, CUPRAC; Cupric ion reducing antioxidant capacity, FPC; Free phenolic content, BPC; Bound phenolic content, TPC; Total phenolic content.

Mineral Content of Gevrek Samples

Table 6 shows the mineral content of gevrek samples supplemented with einkorn and emmer wheat flour. In the gevrek formulations, einkorn substitution caused a higher increase in Ca, Fe, and K content than emmer wheat flour supplement. Sokrab, Ahmed, and Babiker, (2012) reported that Fe and Zn were the least abundant minerals in all wheat varieties and higher amounts were found in einkorn wheat, one of the ancient wheat varieties. Compared to gevreks without einkorn and emmer the highest ratio of ancient wheat (100%) increased the mean values of Ca, Fe, K, Mg and Zn of the gevrek samples by about 1.33-, 4.06-, 2.31-, 2,28- and 1.45-fold, respectively. The rich mineral content of whole wheat flours was directly reflected in the mineral content of the final product. Control samples (0% ancient wheat) produces from refined wheat flour, and ancient wheat was supplemented as whole wheat flour. Ercan (1986) stated that the mineral substances in the wheat grain increase from the center to the outer part, so most of the mineral substances are collected in the outer layers of the wheat grain. Cankurtarn Kömürcü (2021) stated that the mineral content of noodles and bread increased with the addition of whole ancient wheat flour.

Table 6. Mineral content of gevrek samples (mg 100 g^{-1})

	n	Ca	Fe	Mg	K	Zn
Flour types						
Einkorn	10	29.00±4.13a	5.26±2.10a	109.48±32.09a	250.25±79.77a	5.08±0.79a
Emmer	10	26.84±2.35b	3.81±1.86b	99.73±27.24b	237.63±64.45a	5.24±0.81a
Flour ratio (%)						
0	4	24.02±0.28c	1.61±0.21d	60.91±3.60e	148.33±6.07e	4.42±0.20c
25	4	25.00±0.35c	3.50±1.10c	89.77±3.64d	203.14±10.37d	4.86±0.40bc
50	4	28.23±0.97b	4.90±1.84b	106.42±11.97c	243.77±20.33c	4.88±0.25bc
75	4	30.37±2.58a	6.14±0.45a	125.36±6.43b	286.12±18.97b	5.22±0.69b
100	4	31.97±2.47a	6.53±0.74a	140.58±10.90a	338.35±28.76a	6.42±0.23a

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

Sensory Properties of Gevrek Samples

The sensory properties of gevrek samples are presented in Figure 2. The use of 25% einkorn flour in the gevreks revealed superior color and appearance scores to other gevrek samples and the odor score was found to be similar to the control which was prepared with 0% einkorn flour.

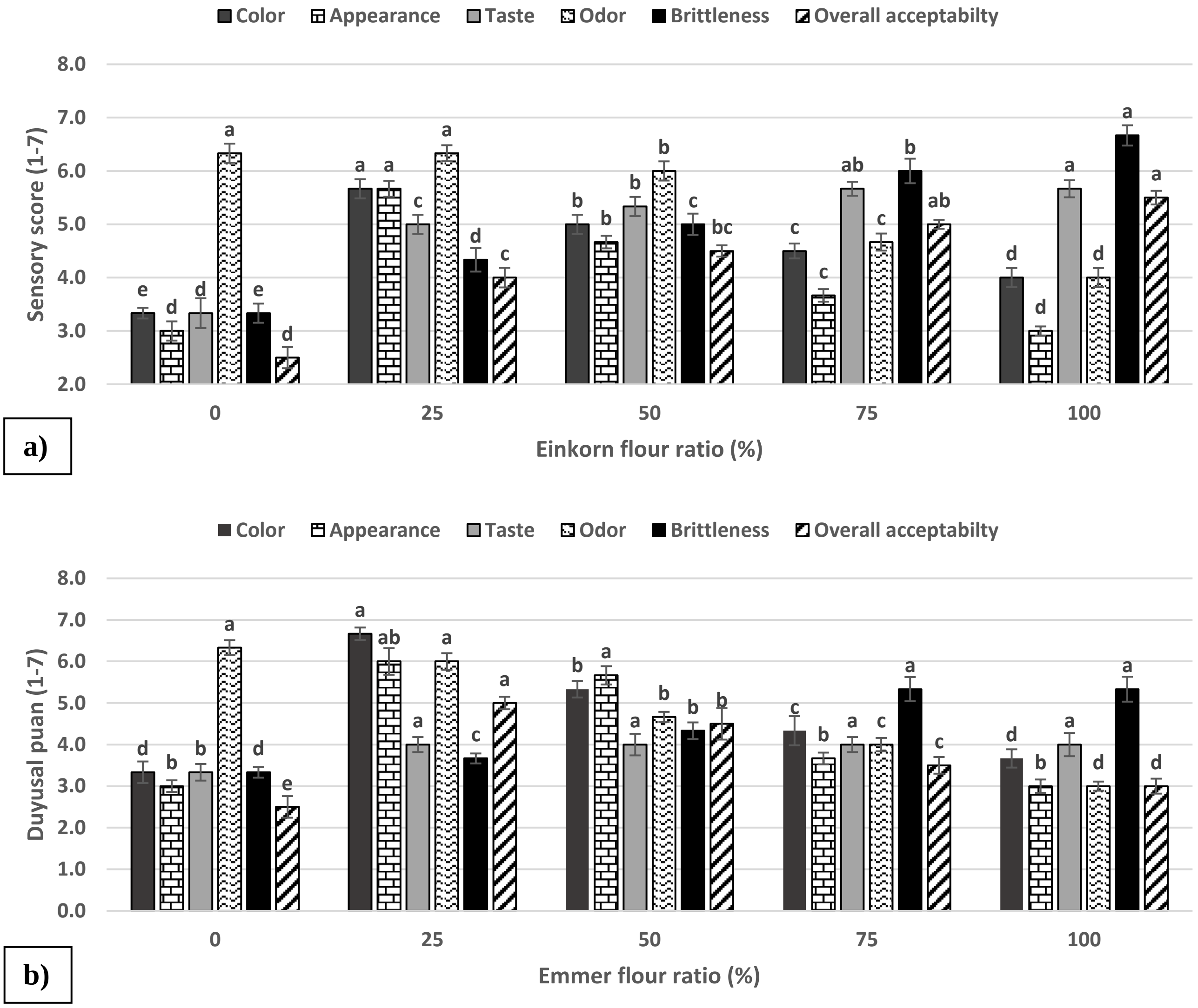

Figure 2. Sensory scores of gevrek samples prepared with einkorn (a), emmer (b)

Gevrek samples containing 25% emmer flour give the highest color and overall acceptability score compared to other gevrek samples, and their odor and appearance characteristics were found to be statistically similar to 0% and 50% emmer wheat flour added gevrek samples, respectively. The odor, brittleness and overall acceptability values were positively affected by the increasing use of einkorn flour. The highest brittleness score was obtained with the use of 100% einkorn flour, the use of 75% and 100% einkorn flour was statistically similar and had higher overall acceptability scores than the other gevrek samples. Increasing the use of emmer flour increased the brittleness value. However, on the contrary to the addition of einkorn, it decreased the overall acceptability scores, but still, the gevrek samples with 100% emmer flour added a higher overall acceptability score than the control sample. Among the samples with the addition of einkorn, the lowest color, appearance, brittleness and overall acceptability scores were obtained for gevrek samples prepared with 0% additive, while the samples with 0% emmer addition received the lowest brittleness and overall acceptability scores among the samples with the addition of emmer flour. When the results were compared in terms of einkorn and emmer wheat varieties; generally, the use of einkorn wheat flour was evaluated by the panelists with higher taste, odor and brittleness scores than the use of emmer wheat flour.

CONCLUSION

This study investigated some quality properties of gevrek samples prepared with einkorn and emmer flour. Usage of einkorn and emmer flour in gevrek formulation decreased the L*, b* Hue and SI value, increased a* value of gevrek samples. The dark and reddish color of the whole einkorn and emmer wheat flour affected the color of gevrek samples and an increased darkness and redness value of samples with the usage of whole ancient wheat flour. Einkorn and emmer usage in gevrek samples decreased the width and firmness value of gevrek samples. Emmer wheat allowed the production of gevrek samples with higher ash, phytic acid and richer bioactive compounds. Moreover, using einkorn and emmer wheat provided a significant increase in ash, protein, fat, phytic acid, antioxidant activity (DPPH, FRAP and CUPRAC), free, bound and total phenolic content and Ca, Fe, Mg, K and Zn content. The results of this study showed that the use of 100% ancient wheat flour resulted in a maximum increase in the nutritional properties of the gevrek samples. The use of einkorn and emmer at the rates of 25% and above in the gevrek positively affected the sensory profile in terms of taste and brittleness scores, however, the overall acceptability scores were higher in the samples with einkorn and emmer flour added at 100% and 25% addition rates, respectively.

Conflict of Interest

The author declares that there is no conflict of interest with other persons and/or institutions.

Yazar Katkısı

Yazarlar makaleye eşit oranda katkı sağlamış olduklarını beyan eder.

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