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Evaluation of The Effects of The Use of Vegetable and Fruit Extracts on Bread Quality Properties

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ABSTRACT

Bread is the basic nutrient that human beings have consumed for centuries. This is because it is affordable, nutritious and satisfying. The most consumed bread on a daily basis is white bread made from refined flours. Since white breads are made from flour that has been separated from the bran and germ, they are poor in other nutrients (dietary fiber, phenolic compounds and minor nutrients) with a high starch content. For this reason, studies on increasing the nutritional value and functionalization of white bread have attracted attention for years. In this study, the changes in physical, chemical, sensory and textural properties of bread were evaluated with the addition of purple cabbage, sorrel, capia pepper, pomegranate, pumpkin and cherry extracts to bread production. It was determined that the bread was enriched with phenolics with the addition of extracts (65% on flour basis) and the best sensory results were the breads with the addition of capia pepper extract.

Türk Tarım – Gıda Bilim ve Teknoloji Dergisi, 10(10): 1838-1844, 2022

Sebze ve Meyve Ekstraktları Kullanımının Ekmek Kalite Özellikleri Üzerine Etkilerinin Değerlendirilmesi

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ÖZ

Ekmek, insanoğlunun yüzyıllardır tükettiği temel besin maddesi konumundadır. Bunun nedeni uygun fiyatlı, besleyici özellikte ve doyurucu olmasıdır. Günlük olarak en fazla tüketilen ekmek ise rafine unlardan elde edilen beyaz ekmeklerdir. Beyaz ekmekler, kepeği ve özü ayrılan undan yapıldığından, nişasta içeriği yüksek diğer besin öğelerince (besinsel lif, fenolik bileşikler ve minör besin öğeleri) fakir kalmaktadır. Bu nedenle beyaz ekmeğin besinsel değerlerinin arttırılması ve fonksiyonel hale getirilmesi çalışmaları yıllardır ilgi çeken konulardandır. Mevcut çalışmada, mor lahana, kuzukulağı, kapya biber, nar, balkabağı ve vişne esktraktlarının ekmek üretimine katılması ile ekmeğin fiziksel, kimyasal, duyusal ve tekstürel özelliklerinde meydana gelen değişimler değerlendirilmiştir. Ekstraktların (un bazında %65) katılımı ile ekmeğin fenoliklerce zenginleştiği ve en iyi duyusal sonuçların kapya biber ekstraktı ilave edilmiş ekmekler olduğu tespit edilmiştir.

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Introduction

Bread is the most important, basic and oldest nutrient known to mankind (Kalkan and Özarık, 2017). The reasons why bread is accepted as one of the basic foods can be shown as being satisfying and nutritious (Özdemir et al., 2021). In Türkiye, approximately 40% of daily energy is obtained from bread. When the world is examined, Türkiye takes the first place in terms of bread consumption with 319 g/day consumption, followed by Denmark with 195 g/day, Finland 140 g/day and England 89 g/day bread consumption (Yurdatapan, 2014).

Generally, bread is obtained from refined wheat flour. Since refined wheat flours are obtained by separating the germ and bran, these flours contain lower vitamins, dietary fiber and minerals compared to whole grain flours. For this reason, white breads obtained from refined wheat flours are not sufficient for increasing consumer demands (Xu et al., 2021). In recent years, the demands for enrichment of bakery products have been increased (Demiray, 2021).

In the beginning, it was seen that folates (Rader et al., 2000), vitamins, minerals (Rosell, 2016) and dietary fibers (Fendri et al., 2016; Foschia et al., 2013; Uzunkaya and Ercan, 1999) were used in the fortification of bread. Later, it was reported that legumes could be a good option due to their nutritional content, and studies in this area have increased. In recent studies, it can be said that fruits and vegetables are used to enrich bread, and this interest is due to many healthy components such as phenolic substances, dietary fibers, minerals and vitamins in fruits and vegetables (Betoret and Rosell, 2019).

Fruits used in bread enrichment are pomelo (citrus) (Reshmi, et al. 2017), blueberry (Rodriguez-Mateos, et al. 2014), pear (Yu et al., 2018), apple (Erdogan, 2010), banana (Ho et al., 2015), apricot (Dhen et al., 2018) can be given as an example. Also, vegetables used in bread enrichment are zucchini, yellow pepper, beetroot, carrot, spinach and chard (Danza et al., 2014; Hobbs et al., 2014; López-Nicolás et al., 2014).

The amounts and forms of fruits and vegetables added to bread for the purpose of enrichment vary considerably according to the studies. While the amounts showed a wide range from 0.5% to 50%, fruits and vegetables were applied to bread in powder, puree, extract, juice, fresh form and mixing them in different ways. In general, the main objective of the studies was the development of the product and the examination of the effects on the technological properties of the final product (Betoret and Rosell, 2019).

When the literature is examined, it is seen that the fruits and vegetables used in bread enrichment are generally added to the products in powder form, and their use in fresh form is very limited. In this direction, the aim of the study is to examine the effects of extracts obtained from pumpkin, sour cherry, pomegranate, capia pepper, sorrel, and purple cabbage on the physical, chemical, sensory and textural properties of bread.

Material And Method

For bread production, purple cabbage, sorrel, capia pepper, sour cherry, pomegranate, pumpkin, instant yeast (Dr. Oetker), wheat flour (Söke, Aydın), salt (Billur, İzmir) was obtained from local stores and potable water was used.

Bread Making

The recipe given by Amendola and Rees (2002) was used in bread making. Bread formulation consists of 200 g wheat flour, 130 g tap water, 4 g salt and 2,4 g yeast. The same amount of extract was used instead of tap water in enriched breads. The extracts were obtained by pressing and filtering purple cabbage, sorrel, capia pepper, pomegranate, pumpkin and cherry. All the ingredients were mixed (Kitchen Aid, Germany) for 6 min. Doughs were cut into 300 g pieces and incubated for 1 h at 27-28°C. Doughs were baked in a stone-based oven (bottom base temperature of 220°C and an upper base temperature of 210°C) for 30 min.

Total Dry Matter, Ash and Color Analysis

In order to determine the total dry matter content of breads, 3-5 g of bread was dried at 105°C until it reached a constant weight, and the total solids content of the samples was determined (AOAC 1990; Cemeroğlu, 2018). For the determination of total ash, 3-5 g of bread was weighed into crucibles and burned at 550-600°C, and the percentage of ash was calculated (AOAC 1990). L (brightness), a (redness-greenness) and b (yellowness-blueness) values used to determine the color characteristics of control and functional breads were measured using a colorimeter device (PCE-CSM 4 Colorimeter, Türkiye). After the breads were baked and cooled, measurements were taken on the crust and crumb the bread and their averages were determined (Su et al., 2005).

Determination of Bread Characteristics

The weights (g) of the breads were determined using precision scales (Radwag, Poland). Bread volume measurement was carried out by millet seed displacement method. First, the volume of the cup (V1) was determined by pouring the millet seeds into the graduated measuring cylinder at a constant speed and distance. Afterwards, the bread, whose volume will be determined, was placed in the same empty container and covered with millet seeds up to the surface of the container, and the volume was recorded as (V2) by measuring again in a graduated measuring cylinder. In the bread volume calculation, the volume was determined by taking the difference of these two volumes (Burton and Lightowler, 2006). Densities of bread samples whose volume and weight were determined were calculated using the following formula.

$$\text{Bread Density (g/cm}^3\text{)} = \frac{\text{Bread Weight}}{\text{Bread volume}}$$

The specific volumes of the bread samples whose volume and weight were determined, were calculated using the formula below.

$$\text{Bread Specific Volume (cm}^3\text{/g)} = \frac{\text{Bread Volume}}{\text{Bread Weight}}$$

The height of the bread was determined from the highest point of the bread cut in half with the help of a caliper (Vernier Caliper, China). Cooking value loss of breads whose baked bread weights and dough weights were determined, were calculated using the formula below (Adal, 2018).

$$\text{Cooking Loss (\%)} = \frac{\text{Dough Weight-Bread Weight}}{\text{Dough Weight}} \times 100$$

Texture Analysis of Breads

Texture Profile Analysis (TPA) of control and functional breads were determined in TA, XT Plus C Texture Analyzer (Stable Micro Systems, England) device, using a 36 mm cylinder probe. Device analysis criteria; target distance was 10 mm, pre-test velocity was 1 mm/s, post-test velocity was 5 mm/s, test velocity was 5 mm/s, 5 kg capacity load cell and trigger force were 5 g. After cooling, the breads were cut at a height of 2,5 cm and analyzed. Analysis results were evaluated on the hardness of breads (Su et al., 2005; Alkay et al., 2020).

Analysis of Total Phenolic Matter Content of Breads

The total phenolic content of the breads was determined according to the Folin-Ciocalteu method. 1 hour after the breads were baked, 2 g were weighed and ground. 10 mL of methanol:water (1:1) mixture was added to them, then the extraction step was completed by keeping them in an ultrasonic bath (Weightlab Inst., Türkiye) for 15 minutes (80 W 40 kHz). By centrifugation (Electromag, Türkiye) for 15 minutes at 4100 rpm, 0,5 mL supernatant was taken into spectrophotometer cuvettes. After adding 2 mL of folin solution and 1 mL of sodium carbonate solution (7%), it was kept in the dark for 30 minutes. Absorbance values were measured at 750 nm in a spectrophotometer (Soif UV-5100B, China), and the total content of phenolic substance was expressed as mg Gallic acid /100 g. The calibration curve was prepared with a gallic acid standard dissolved in methanol in the range of 0-200 mg/L (Arslan Burnaz et al., 2018; İnce and Çağındı, 2020).

Extensibility Properties of Dough

To determine of the dough properties, Kieffer et al. (1998) was used with a few modifications. After weighing 10 g of fermented dough, it was pressed between greased hard plastic plates at 30°C for 30 minutes. Then, the dough pieces divided between the plates were carefully removed with the help of a thin spatula and placed in the device. The device parameters were determined as test speed of 3,3 mm/s and target distance of 75 mm. Analysis was performed on TA, XT Plus C Texture Analyzer (Stable Micro Systems, England) device using SMS/Kieffer Dough and Gluten Extensibility Rig (Buresova et al., 2014).

Sensory Analysis of Breads

Descriptive analysis was used to examine sensory characteristics. In the analysis, a total of 20 panelists, both educated and semi-trained, were evaluated using a 7-point hedonic scale (1- at least 7- at most) in terms of odour, taste, color, general acceptability, and firmness properties, after the baked breads have cooled. Panelists consist of Kutahya Dumlupinar University Pazarlar Vocational School students and academics (Feili et al., 2013). Acceptability index (AI) was calculated according to the method reported in Kaur et al. (2020).

$$\text{AI (\%)} = (\text{Overall acceptability score} \times 100)/7$$

Statistical Analysis

The significance of the difference ($P<0.05$) between the data obtained in the whole analyzes were calculated using the Tukey test and revealed by one-way analysis of variance (ANOVA). All analyzes were repeated three times and data was expressed as mean ± standard deviation. SPSS Statistic 22 (SPSS INC., Chicago, IL, USA) software package was used for statistical analyzes.

Results and Discussions

Moisture, total ash, weight, height, specific volume, cooking loss, crumb and crust color analysis results of breads with fruit and vegetable extracts are given in Table 1. It was observed that the ash content of all breads which fruit and vegetable extracts were added increased. According to the results, the highest ash content was determined in pumpkin added bread between fruit breads and purple cabbage added breads between vegetable breads. Studies on the ash content of these fruits and vegetables were examined and 0.77 g/100g ash content in pumpkin extract (AlJahani and Cheikhousman, 2017) and 0.87g/100g ash content in purple cabbage vegetable were determined, respectively. In a study examining the properties of bread with purple cabbage extract, it was observed that the total ash content increased by 23% compared to the control bread. In our analysis results, an increase of 26% was recorded in the content of ash with the addition of purple cabbage extract (Asir and Refiker, 2021). In another study, the addition of red pepper powder was increased ash content of bread proportionally (Kaur et al., 2020).

When moisture analyzes were examined, it was observed that breads with vegetable extract generally had higher moisture content than breads with fruit extract (Table 1). It can be said that the reason for this is that the moisture contents of vegetable extracts are higher than fruit extracts. The moisture contents of the vegetable extracts obtained before the analysis were determined as approximately 98, 93, and 93% for sorrel, capia pepper and purple cabbage, respectively, 91, 89 and, 86% for pumpkin, sour cherry and pomegranate extracts, respectively. Accordingly, the highest moisture content was determined in pumpkin added bread between fruit breads and sorrel added breads between vegetable breads. Rakcejeva et al. (2011) reported that the amount of water added during dough making affects the moisture content of the product. Moisture of breads with pomegranate extract added was statistically significant ($P<0.05$).

When the specific volume and bread heights of the breads were examined, it was determined that the highest values were in the control bread, among the breads with fruit extract, pumpkin bread, and among the breads with vegetable extract, capia pepper breads. It is similar to other studies that the addition of ingredient causes reductions in the specific volume of breads (Bakare et al., 2016; Kaur et al., 2020).

According to the results of the study, the cooking loss values in the breads which the extract was added were found to be higher than the control bread. When the cooking losses of breads with vegetable and fruit extract are compared, the cooking loss values of the samples which vegetable extract was added were found to be lower than the samples which fruit extract was added. It has been reported that the content of protein in vegetable and fruit extracts can affect the structure of the product, and the increased content of protein can reduce the degrading effects of dietary fiber and diluted gluten (Bustos et al., 2015).

When bread crumb and crust values were examined, it was observed that a (redness-greenness) and b (yellowness-blueness) values also varied in parallel with the color values of fresh fruit and vegetable extracts. Brightness values were recorded to be smaller in breads with added fruit and vegetable extracts compared to the control bread. The lowest brightness value was recorded in capia pepper breads among vegetable breads and pomegranate breads among fruit breads. It has been reported that while L values decrease in breads with capia and pumpkin added, increases in a and b values are observed (Rakcajeva et al., 2011; Kaur et al., 2020).

Table 1. Physical analyses results of breads enriched with different fruit and vegetable extracts

Analysis	Control	Pumpkin B.	Sour Cherry B.	Pomegranate B.	Sorrel B.	Capia Pepper B.	Purple Cabbage B.
Ash (%)	0.64±0.02^{a}	0.88±0.05^{c}	0.74±0.03^{b}	0.74±0.00^{b}	0.71±0.03^{ab}	0.74±0.01^{b}	0.81±0.03^{bc}
Moisture (%)	43.43± 1.15^{b}	42.67±0.74^{b}	42.26±0.81^{b}	38.05±0.47^{a}	43.76±1.47^{b}	44.07±1.00^{b}	42.08±0.29^{b}
Weight(g)	180.38±0.56^{b}	170.81±1.27^{a}	169.17±0.71^{a}	171.75±1.57^{a}	184.31±0.99^{c}	179.31±0.60^{b}	179.31±0.49^{b}
Height (mm)	4.84±0.03^{c}	4.79±0.04^{c}	4.46±0.03^{b}	3.87±0.02^{a}	4.76±0.01^{c}	5.76±0.03^{e}	4.99±0.02^{d}
Cooking Losses (%)	14.1	18.66	19.44	18.21	14.23	14.59	14.61
Specific Volume	2.96±0.07^{d}	2.84±0.02^{d}	2.31±0.04^{b}	2.17±0.01^{a}	2.49±0.03^{c}	2.87±0.01^{d}	2.84±0.04^{d}
Crumb Color							
L	55.23±2.40^{b}	50.23±2.43^{ab}	52.23±3.93^{ab}	48.00±3.65^{ab}	52.63±0.50^{ab}	45.76±1.60^{a}	47.21±3.14^{ab}
a	1.62±0.18^{a}	4.88±0.37^{c}	12.53±0.38^{d}	12.52±0.40^{d}	2.29±0.09^{ab}	21.37±0.73^{e}	3.53±0.20^{b}
b	13.09±0.4^{d}	29.49±0.66^{f}	8.44±0.09^{c}	5.89±0.11^{b}	26.50±0.13^{e}	39.00±1.25^{g}	1.24±0.28^{a}
Crust Color							
L	75.22±0.46^{c}	65.69±0.05^{b}	53.96±3.55^{a}	65.09±0.26^{b}	73.99±1.87^{c}	55.98±1.41^{a}	55.49±0.99^{a}
a	13.48±1.59^{b}	11.40±0.42^{b}	14.49±0.48^{b}	12.98±0.25^{b}	1.21±0.01^{a}	21.47±0.77^{c}	13.48±1.59^{b}
b	23.50±0.04^{c}	36.04±1.72^{d}	6.47±0.23^{a}	15.62±1.28^{b}	21.13±2.72^{bc}	41.28±2.05^{d}	16.25±1.73^{b}

B: Bread

Table 2. Total phenolic content of breads enriched with different fruit and vegetable extracts

Breads	Total Phenolic Content (mg GAE/100 g)
Control	28.34±0.74^{a}
Pumpkin Bread	46.83±2.91^{b}
Sourcherry Bread	120.47±5.84^{e}
Pomegranate Bread	120.77±6.23^{e}
Sorrel Bread	69.11±2.60^{c}
Capia Pepper Bread	88.25±1.31^{d}
Purple Cabbage Bread	66.23±0.55^{c}

Table 3. Textural properties of breads and rheological properties of doughs enriched with different fruit and vegetable extracts

Dough/Bread	Resistance to Extension (g)	Extensibility (mm)	Hardness (g)
Control Dough/Bread	13.98±0.30^{a}	-52.88±2.26^{a}	458.53±29.50^{a}
Pumpkin Dough/Bread	21.43±1.31^{c}	-19.04±0.33^{b}	371.13±40.17^{a}
Sourcherry Dough/Bread	21.92±0.93^{c}	-20.49±0.83^{b}	380.73±30.89^{a}
Pomegranate Dough/Bread	19.44±0.57^{bc}	-15.22±2.02^{b}	409.17±5.34^{a}
Sorrel Dough/Bread	20.22±1.84^{bc}	-18.77±3.20^{b}	458.83±70.86^{a}
Capia Pepper Dough/Bread	22.98±2.39^{c}	-21.21±1.84^{b}	352.48±41.38^{a}
Purple Cabbage Dough/Bread	15.94±2.10^{ab}	-20.91±2.21^{b}	490.24±47.52^{a}

The use of fruits and vegetables in the enrichment of breads seems to be more advantageous because they are cheaper, easily accessible and rich in phenolic substances such as phenolic acid, anthocyanins, flavonoids, catechins, and vitamin C (Dziki et al., 2014; Ibrahim et al., 2015). When the literature is examined, it is seen that the addition of fruit and vegetables to breads is usually done in powder form, and in a few studies, it is used directly or its extract (Betore and Rosell, 2019; Dziki et al., 2014). During the drying process applied to turn the products into powder, a certain content of phenolic substance loss may occur. The total phenolic content of the breads is given in Table 2. It was observed that there was a statistically significant increase in the phenolic content of all breads added fruit and vegetable compared to the control bread ($P<0.05$). In a study in which bread was made with purple cabbage extract, it was stated that the total phenolic content increased by 2.5 times when compared to the control bread, and it seems that our results are similar (Asir and Refiker, 2021). In another study, bread was prepared with red pepper powder and the content of phenolic substance increased by about 2 times compared to the control bread

(Kaur et al., 2020). In our study, this increase is approximately 3,2 times when fresh capia pepper extract is used. Since pumpkin is a product rich in carotenoids, it makes richer in terms of phenolic substances. In a previous study, pumpkin was added to breads in powder form and it was reported that it caused an approximately 2-fold increase in phenolic content in breads with 10% addition (Wahyono et al., 2020; Rakcejeva et al., 2011). No study was found using sour cherry fruit for the enrichment of breads, and the use of pomegranate in breads is generally in the form of pulp or seed powder. In such case are expressed, when compared to the control bread, phenolic content increases ranging from 2.5 times to 5 (Bhol et al., 2016; Bourekoua et al., 2018). There was no study investigating the change in the content of phenolic substances in bread with sorrel.

Figure 2. The images of breads

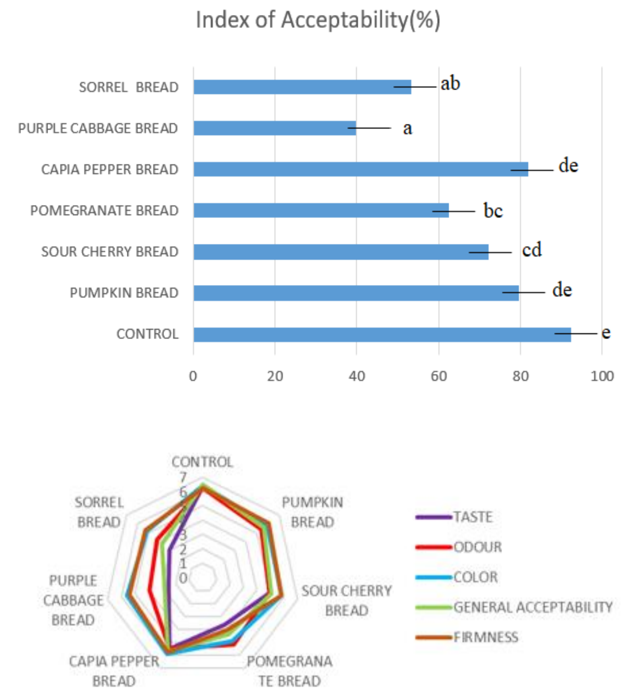

Figure 1. Radar graph of sensory evaluation of breads and general acceptability index values

Textural properties of breads and rheological properties of doughs enriched with different fruit and vegetable extracts are given in Table 3. While there was a statistically significant difference in terms of extensibility values between the dough with fruit and vegetable addition and the control, the extensibility values between the added breads did not create a significant difference ($P<0.05$). The fact that enriched doughs have lower resistance values than control doughs may be due to the fact that these doughs are harder. This is because the polyphenols in fruits and vegetables can interact with the proteins in the dough and damage the disulfide bonds. This may reduce the ratio of high molecular weight proteins in the dough and causes the formation of an insufficient gluten network (Betoret and Rosell, 2019; Xu et al., 2019). Due to similar reasons, the resistance of doughs to extension is lower in control dough than in added doughs.

Fruit and vegetable extracts significantly affected the sensory properties of the breads produced (Figure 1). While taste, smell, and general acceptability scores created significant differences between breads, color, and firmness scores were quite similar to each other and did not create a significant difference. The images of the breads are given in Figure 2. Capia pepper bread had the highest mean score followed closely by pumpkin bread. The results were similar to those obtained by Hobbs et al. (2014), with red pepper bread getting the highest scores in that study as well. In another study, it is seen that the addition of 10% or more sorrel seed isolate causes a decrease in the taste, color, smell, texture, appearance and general acceptability scores of breads (Sanni et al., 2020). In our results, it is seen that sorrel bread has one of the lowest taste and general acceptability values.

Conclusion

Fruits and vegetables are important raw materials for the enrichment of bread, as they are rich in nutritional content. In the study, a statistically significant increase was found in the phenolic content of all breads added fruit and vegetable extracts compared to the control bread. The ash content of all bread to which the extract was added also increased. The addition of fruit and vegetable extracts increased the baking loss of breads and caused a decrease in their specific volume. This situation could be interpreted as the polyphenol content in vegetable and fruit extracts affects the structure of the product. According to the results of sensory analysis, the bread with the highest taste and general acceptability scores was determined as bread with capia pepper extract, and the bread with the lowest score was determined as bread with sorrel extract.

Compliance With Ethical Standards

Conflict of Interest

The authors declare that they have no conflict of interest.

Authors' Contributions

Meryem Akbaş

Writing manuscript, data analysis, conducting test and analysis.

Hilal Kılmanoğlu

Conducting test and analysis, editing manuscript and data analysis.

Ethical Approval

Not applicable.

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