

PRODUCTION OF BREADSTICKS ENRICHED WITH HAWTHORN FRUIT*

Fatma Cebeci*¹, Dilan Eryılmaz¹, Tuğçe Geyik¹, Çağla Yılmaz¹

Original scientific article

Abstract

The common hawthorn (*Crataegus monogyna*), is a member of the Rosaceae family that is native to Europe, Africa, and Asia. Scientific research has shown that the presence of various bioactive substances such as epicatechin and chlorogenic acid in hawthorn fruit results in strong antioxidant and free radical scavenging properties. This study investigated the preparation of hawthorn fruit-enriched breadsticks. The study aimed to produce a healthy snack with health-promoting effects and evaluate its nutritious and antioxidant properties. Breadsticks were prepared by adding different ratios of hawthorn to the dough (5%, 10%, 15%). Proximate (moisture, ash, fat, protein), total phenolic content and sensory analyses were performed. Hawthorn-enriched breadsticks were compared with no hawthorn-added breadsticks. The sensory analysis showed only a color difference between the hawthorn containing different amounts of breadsticks. According to the evaluation of the participants, there was no statistically significant difference in odor, brittleness, flavor and general liking among the breadstick samples ($p>0.05$). According to the results, as the amount of hawthorn powder increased, the amount of total phenolic substance in the samples increased at a statistically significant level ($p<0.05$). This shows that the aim of enriching the phenolic content with adding hawthorn was successfully achieved. Further studies will focus on optimizing the recipe to show better sensory qualifications.

Keywords: *Hawthorn, breadstick, total phenolic content, sensory analysis, food enrichment*

INTRODUCTION

Adequate and balanced nutrition strengthens the immune system, prevents non-communicable diseases, and indirectly extends human life (Bojang and Manchana, 2023). On the other hand, malnutrition or nutrient deficiencies still remain an important risk affecting human health.

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¹ Bayburt University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Bayburt, Türkiye
Correspondence: fatmacebeci@bayburt.edu.tr

Micronutrient deficiency is a global public health problem and can cause severe diseases. Iron, folate, vitamin A, zinc, and iodine are generally the most common micronutrient deficiencies (Demircioğlu and Aslan, 2023). The vitamin-mineral content of foods varies depending on various factors such as soil and irrigation conditions, food preparation, and cooking methods (Uluğ and Rakıcıoğlu, 2019). Food fortification techniques have gained significant attention in recent years as a solution to the problem of how to acquire these vitamins and minerals, which are often lost. Enriched foods are useful when micronutrients are either insufficient or impossible to obtain from the food (Demircioğlu and Aslan, 2023).

Since it was determined that the antioxidant properties of wild fruits growing spontaneously in nature are higher than cultivated fruits, the demand for wild fruits has increased in recent years (Tüysüz *et al.*, 2021). Fruits such as hawthorn, pomegranate, elderberry, blackcurrant, and raspberry are wild fruits (İlhan *et al.*, 2019). Wild fruits seem a good option for a food fortification approach since they grow spontaneously without human influence and contain many minerals and vitamins that are essential for maintaining a healthy life (İlhan *et al.*, 2019; Şengün and Yücel, 2015). They provide health-promoting effects thanks to not being exposed to chemical applications; their composition is rich in antioxidants and composed entirely of natural compounds (İlhan *et al.*, 2019).

Hawthorn stands as a good candidate for new and healthier recipes. Numerous research have demonstrated the anti-inflammatory, anti-cancer, antioxidant, cardioprotective and digestive-enhancing qualities of hawthorn. Its primary chemical constituents, pentacyclic triterpenoids (ursolic acid, hawthornic acid, and oleanolic acid), and polyphenols (chlorogenic acid, proanthocyanidin B2, epicatechin, proanthocyanidins, mucoxanthin, quercetin, and rutin) are linked to its bioactive effects (Zhang *et al.*, 2022). Hawthorn was determined as a "Traditional Herbal Medicinal Product" by the European Medicines Agency Herbal Medicinal Products Committee. It is also included in the pharmacopoeias of countries such as China, Germany, France, and England (Alkan and Gülmemiş, 2022). It is used in the treatment of diabetes in Mexico; in the treatment of cardiovascular diseases, digestive disorders, hyperlipidemia, and hypertension in China and Korea; in the treatment of diabetes, cardiovascular diseases, and cancer in traditional Arab medicine; and in the treatment of hemorrhoids, sore throat, cough, nephritis and rheumatism in Türkiye. It is consumed as raw fruit or used to produce vinegar. In addition, hawthorn is used in producing sunscreen in cosmetics, as a coating agent in industry, and in preparing punch and canning thanks to its high pectin content (Güler, 2023). This study aimed to produce hawthorn fruit-enriched breadsticks with health-promoting effects thanks to the high antioxidative potential of hawthorn.

MATERIALS AND METHODS

Preparation of hawthorn powder

The hawthorn was picked from Elazığ, Çötelî district in Türkiye. The supplied hawthorns were washed to remove dirt then the seeds were removed. The hawthorns were put through a grinder. Ground hawthorn was dried in the oven at 50°C, so that hawthorn powder (HP) was produced (Figure 1) and stored at -18 °C until use.



Figure 1. The hawthorn powder used in the study

Preparation of breadsticks

The increasing amounts of HP (5%, 10%, and 15%) were used to replace the wheat flour in breadstick formulations given in Table 1. Fresh yeast was mixed with warm water (37°C) and waited 10 min to activate. Later, all ingredients were mixed together for 10 min. The prepared breadsticks were fermented for 30 minutes at 40°C and then divided into 80 g pieces. Then, the shaped breadsticks with hawthorn were baked in the oven at 150°C for 50 minutes. Finally, they were left to cool. After cooling, breadsticks were weighed. The loss as a result of baking was calculated and baking loss was determined.

Table 1. Formulations of the breadsticks produced in the study.

Ingredient	0 HP	5 HP	10 HP	15 HP
HP (%)	%0	%5	%10	%15
HP (g)	-	30	60	90
Wheat Flour (g)	600	570	540	510
Sugar (g)	24	24	24	24
Salt (g)	9	9	9	9

Yeast (g)	15	15	15	15
Oil (ml)	125	125	125	125
Water (ml)	240	240	240	240

* HP; hawthorn powder

Proximate analysis

The dry matter amount was determined according to the AOAC 930.04 standard method. 2 g of samples were dried at 105°C for 3 hours using a drying oven (Memmert, Germany). The total ash amount of the samples was determined according to AOAC 923.03 standard method. 2 g of each sample was burned at 550 °C using a muffle furnace (Carbolite Gero, England) (AOAC, 1995).

Total fat content was determined using TSE EN ISO 11085 method (TSE, 2016). Protein determination was made using the Bradford method, which is applicable to cereals (Morosan *et al.*, 2022).

Total phenolic content determination

Total phenolic contents (TPC) of the samples were measured according to Zlatanovic *et al.* (2019) by using Folin Ciocalteu method. For analysis, breadsticks were ground using a coffee grinder (Bosch, Germany). Ground breadsticks (100 mg) were extracted with 1400 µL mixture of ethanol and water (1:1) at room temperature for 60 min. Supernatant was obtained by centrifugation at 12,000 rpm for 10 min. After extraction, the extracts (0.25 ml) were mixed with 1.25 ml Folin-Ciocalteu's phenol reagent (10-fold dilution) and left 6 min for reaction. Later, 1 ml sodium carbonate solution (75 g/l,) was added into the mixture and shaken. After reacting for 2 h at room temperature in dark, absorbance was measured at 765 nm using a spectrometer (UV 1800 Shimadzu, Japan). The results were calculated using a calibration curve ($R^2=0,99$) and expressed as mg of gallic acid equivalents per gram of sample (mg (GAE)/g).

Sensory analysis

The sensory attributes of the breadsticks were performed with 20 untrained panellists consisting the staff of Faculty of Health Sciences in Bayburt University. The breadstick sensory analysis was performed using a 7-point hedonic scale (1= dislike; 2 = dislike moderately; 3 = dislike slightly; 4 = neither like nor dislike; 5 = like slightly; 6 = like moderately; and 7 = like very much) (Altuğ Onoğur and Elmacı, 2011). The fresh breadstick samples were placed onto the identical plate and coded with different 3-digit numerical codes. Each sample was presented to the panelists in a randomized order so

that each sample appeared in a particular position. The taste-free water was used for palate cleansing between samples. Then, they were asked to rate the samples based on a scale for each of the following attributes: colour, odor, brittleness, flavour, and general liking.

Statistical analysis

Analyses were performed in triplicate. Data were compared by ANOVA, including post hoc comparison Tukey's test, at the probability level $\alpha = 0.05$ using IBM SPSS Version 22 for Windows.

RESULTS AND DISCUSSION

HP addition showed an effect on the moisture of the breadsticks, and the control breadstick (0% HP added) had the highest moisture (Table 2). On the other hand, there was no significant difference between HP added breadsticks. 15% HP added breadsticks had the highest ash content, possibly thanks to high mineral content of hawthorn as reported in a previous study (Borczak *et al.*, 2016). Although four formulations had the same amount of oil in the recipes, HP addition significantly increased fat content. Protein determination results showed that using hawthorn instead of wheat flour in the formulation decreased the breadsticks' protein content (Table 2). The protein content of 0% and 5% HP-added breadsticks were at the same level and were found to be significantly higher than 10%, and 15% HP-added breadsticks ($p < 0.05$). This result can be explained by hawthorn's lower protein content than wheat flour. Fresh hawthorn was reported to have a protein content of %3,03 (Zhang *et al.*, 2022). There was no significant difference between samples in terms of baking loss.

Table 2. Compositions and the baking loss of the breadsticks

Samples	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Baking loss (%)
0 HP	5,07±0,99 ^a	2,29±0,21 ^{ab}	14,58±0,11 ^d	9,02±0,16 ^a	28,75±4,33 ^a
5 HP	2,90±0,20 ^b	1,97±0,23 ^b	15,38±0,08 ^c	9,64±0,45 ^a	30,41±0,72 ^a
10 HP	2,43±0,10 ^b	2,46±0,17 ^{ab}	16,13±0,17 ^b	7,59±0,33 ^b	30,83±0,72 ^a
15 HP	2,71±0,3 ^b	2,57±0,19 ^a	17,04±0,01 ^a	5,28±0,00 ^c	33,33±0,72 ^a

* HP; hawthorn powder. Different superscript letters indicate a significant difference between samples (Tukey, $p < 0.05$). The results are expressed as mean \pm SD.

According to the results, as the amount of hawthorn increased, the amount of total phenolic content in breadsticks increased at a statistically significant level ($p < 0.05$). This shows that the aim of enriching the phenolic content by adding hawthorn was successfully achieved, as seen in Table 3. A previous study investigating the effect of wild fruits on the nutritional properties of wheat flour bread also included hawthorn in

the study design. The results revealed that bread with 5% lyophilized hawthorn had significantly higher content of total phenolic content and antioxidant activity compared with the control bread ($p < 0.05$) (Borczak *et al.*, 2016).

Table 3. Total phenolic content of the breadsticks

Samples	Total phenolic content (mg GAE/ g sample)
0 HP	0,67±0,01 ^d
5 HP	0,98±0,04 ^c
10 HP	1,06±0,00 ^b
15 HP	1,17±0,04 ^a

* HP; hawthorn powder. Different superscript letters indicate a significant difference between samples (Tukey, $p < 0.05$). The results are expressed as mean \pm SD.

The sensory analysis revealed that as the hawthorn percentage increased, there was no change in sensory properties other than color. Panelists did not like the color change due to the increased amount of hawthorn fruit, as seen in Figure 2. According to the evaluation of the participants, there was no statistically significant difference in odor, brittleness, flavor, and general liking among the breadstick samples ($p > 0.05$); the results are given in Table 4.



Figure 2. Breadsticks produced in this study. HP; hawthorn powder

Table 4. Sensory properties of the breadsticks

Properties	0 HP	5 HP	10 HP	15 HP
Color	5,75±1,48 ^a	4,50±1,5 ^b	4,70±1.17 ^{ab}	4,10±1.44 ^b
Odour	5,15±1,22 ^a	4,70±1,62 ^a	4,55±1,39 ^a	4,15±1,34 ^a
Brittleness	4,60±1,75 ^a	4,25±1,74 ^a	4,00±1,62 ^a	4,20±1,24 ^a
Flavor	5,05±1,31 ^a	4,60±1,66 ^a	4,35±1,42 ^a	3,85±1,38 ^a
General liking	5,25±4,90 ^a	4,90±1,58 ^a	4,60±1,14 ^a	4,50±1,14 ^a

* HP; hawthorn powder. Different superscript letters indicate a significant difference between samples (Tukey, $p < 0.05$). The results are expressed as mean \pm SD.

CONCLUSIONS

This study reported no negative effects of hawthorn addition on the sensory properties of breadsticks except the color. Further studies will focus on optimizing the recipe to show better sensory qualifications. For instance, using freeze-drying may improve the hawthorn powder's color, enhancing the color of breadsticks. Hawthorn powder addition significantly increased total phenolic content of breadsticks and 10% hawthorn powder added breadstick seems to be better compared to others for sensory attributes. Future studies can focus on developing value-added foods or supplements using this wild fruit.

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PROIZVODNJA KRUŠNIH ŠTAPIĆA OBOGAĆENIH PLODOVIMA GLOGA

Sažetak

Obični glog (*Crataegus monogyna*) član je porodice Rosaceae, a porijeklom je iz Europe, Afrike i Azije. Naučna istraživanja pokazala su da prisutnost raznih bioaktivnih tvari poput epikatehina i hlorogene kiseline u plodu gloga rezultira snažnim antioksidativnim svojstvima i svojstvima hvatanja slobodnih radikala. Ova je studija istraživala pripremu krušnih štapića obogaćenih plodom gloga. Cilj studije bio je proizvesti zdravu grickalicu s učincima koji promiču zdravlje i procijeniti njegova nutritivna i antioksidativna svojstva. Krušni štapići pripremljeni su dodavanjem različitih omjera gloga u tijesto (5%, 10%, 15%). Provedene su približne analize (vlaga, pepeo, masti, proteini), ukupnog sadržaja fenola i senzorne analize. Krušni štapići

obogaćeni glogom uspoređeni su s krušnim štapićima bez dodanog gloga. Senzorna analiza pokazala je samo razliku u boji između gloga koji sadrži različite količine krušnih štapića. Prema procjeni sudionika, nije bilo statistički značajne razlike u mirisu, krhkosti, okusu i općem ukusu među uzorcima hljeba ($p>0,05$). Prema rezultatima, s povećanjem količine glogovog praha, količina ukupnih fenolnih tvari u uzorcima povećavala se na statistički značajnoj razini ($p<0,05$). To pokazuje da je cilj obogaćivanja fenolnog sadržaja dodavanjem gloga uspješno postignut. Daljnja istraživanja usredotočit će se na optimizaciju recepta kako bi se pokazale bolje senzorne kvalitete.

Ključne riječi: *Glog, hljeb, ukupni fenolni sadržaj, senzorna analiza, obogaćivanje hrane*