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Determination of various physical, structural properties and sensory acceptability of Hatay Kömbe cookies produced from Ancestral Seed Kavılca (*Triticum dicoccum* L.)

Ata Tohumu Kavılca (Triticum dicoccum L.) ile üretilen kurabiyelerin çeşitli fiziksel, yapısal özellikleri ve duyusal kabul edilebilirliğinin belirlenmesi

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ABSTRACT
The objective of this study was to investigate the browning index, baking weight loss, texture, fatty acid composition and sensory properties of Hatay Kömbe cookies produced using ancient whole wheat flour Kavılca and white wheat flour. Kavılca, an ancient wheat variety cultivated for thousands of years in the Anatolian region of Turkey, is a substantial source of dietary fibre, contains comparatively low levels of gluten, while being abundant in essential nutrients such as B vitamins, zinc and magnesium. Hatay Kömbe, which has a geographical indication, is a type of sweet cookie that is baked after being shaped in traditionally produced wooden moulds. It is characterised by a distinctive spicy dough composition that pice mixture consists of powder cinnamon, allspice, clove, muscat, ginger, mahaleb and mastic gum. In this study, the physical, functional and nutritional properties of Hatay Kömbe cookies were significantly improved by using whole wheat Kavılca flour. The baking weight loss percentage was ascertained to be 10.34% for HKW and 34.08% for HKK, with no significant variance observed in these values over the storage period of two months. The browning index was determined to be 37.73 for HKW and 123.53 for HKK. The fracturability values of the products recorded as 47.72 for HKW and 48.97 for HKK. In comparison to HKW, HKK exhibited a softer texture and higher fracturability. The sensory characteristics of the production made with Kavılca flour founded to be highly regarded by experts, particularly in relation to its aroma and overall acceptability. Consequently, the utilisation of cookies fortified with ancient whole wheat flour has the potential to yield products that offer enhanced health benefits, particularly when incorporated into grain-based products such as Hatay Kömbe cookies, which is designated with a geographical indication.

Key Words: Kavılca, *Triticum dicoccum* L., Hatay Kömbe, Geographical indication

ÖZ
Bu çalışmanın amacı, antik tam buğday unu Kavılca ve beyaz buğday unu kullanılarak üretilen Hatay Kömbe kurabiyelerinin esmerleşme indeksi, pişirme ağırlık kaybı, dokusu, yağ asidi bileşimi ve duyusal özelliklerini araştırmaktır. Türkiye'nin Anadolu bölgesinde binlerce yıldır yetiştirilen antik bir buğday çeşidi olan Kavılca, önemli bir diyet lifi kaynağıdır, nispeten düşük seviyelerde glüten içerirken, B vitaminleri, çinko ve magnezyum gibi temel besin maddeleri açısından zengindir. Coğrafi işareti bulunan

Hatay Kömbe, geleneksel olarak üretilen ahşap kalıplarda şekillendirilerek pişirilen bir tür tatlı kurabiyedir. Toz tarçın, yenibahar, karanfil, misket, zencefil, mahlep ve sakızdan oluşan parça karışımı ile belirgin bir baharatlı hamur bileşimi ile karakterizedir. Bu çalışmada, tam buğday Kavılca unu kullanılarak Hatay Kömbe kurabiyelerinin fiziksel, fonksiyonel ve besinsel özellikleri önemli ölçüde iyileştirilmiştir. Pişirme ağırlık kaybı yüzdesi HKW için %10.34 ve HKK için %34.08 olarak belirlendi ve iki aylık depolama süresi boyunca bu değerlerde önemli bir değişiklik gözlenmedi. Esmerleşme indeksi HKW için 37.73 ve HKK için 123.53 olarak belirlendi. Ürünlerin kırılabilirlik değerleri HKW için 47.72 ve HKK için 48.97 olarak kaydedildi. HKK kurabiyeleri HKW kurabiyelerine kıyasla daha yumuşak bir doku ve daha yüksek kırılabilirlik sergiledi. Kavılca unu ile yapılan üretimin duyusal özellikleri, özellikle aroması ve genel kabul edilebilirliği açısından uzmanlar tarafından oldukça beğenildi. Sonuç olarak, eski tam buğday unu ile güçlendirilmiş kurabiyelerin kullanımı, özellikle coğrafi işaretle belirlenmiş Hatay Kömbe gibi tahıl bazlı ürünlere dahil edildiğinde, gelişmiş sağlık yararları sunan ürünler üretme potansiyeline sahiptir.

Anahtar Kelimeler: Kavılca, *Triticum dicoccum*, Hatay Kömbe, Coğrafi işaret

Introduction

In recent years there has been a resurgence of interest in ancient seeds, driven by concerns about biodiversity, food security and health. Ancestral seeds, also known as heirloom or heritage seeds, are non-hybridised seeds that have been passed down through generations, often preserving the unique characteristics of crops. Unlike commercially produced seeds, which are bred for uniformity and large-scale cultivation, heirloom seeds maintain genetic diversity and adaptability to local climates (Ray, 2012; Shiva, 2022). This renewed focus is fuelled by the worldwide movement towards sustainable agriculture, slow food and organic farming, as more people recognise the risks of monoculture and genetically modified organisms (GMOs). Ancestral seeds represent not only a cultural heritage but also an agricultural strategy to withstand environmental challenges such as climate change. Their resilience helps to ensure that smallholder farmers, especially in regions vulnerable to environmental changes, can maintain crop yields without relying on chemical inputs (Aistara, 2018). Consumers are also showing an increasing preference for organic and locally sourced food (Mısır and Koç, 2023). This is driving farmers to grow crops from heirloom seeds that are perceived to have superior taste, nutritional value and environmental impact. Seed-saving initiatives, community seed banks and collaborations between scientists and indigenous groups are becoming common practices to protect these vital seeds from extinction (Schmitz et al., 2023). In the main, the increasing focus on ancient seeds is part of a wider trend emphasising sustainability, food sovereignty and biodiversity conservation, reflecting society's desire to reconnect with its agricultural roots and safeguard the future of food production (Petrini, 2003).

Kavılca flour, also known as emmer wheat, is an ancient wheat variety that has been cultivated for thousands of years, especially in the Anatolian region of Turkey. One of the oldest known wheat varieties is distinguished by its sturdy husk and high nutritional value, including fibre, protein and essential vitamins. This grain is respected for its robust, earthy flavor and is often used in the production of bread, pastries and traditional dishes (Speck, 2011; Aydar 2022; Özgören and Işık 2023). Kavılca, produced by traditional methods, is a product with high protein value, these values range from 13.45% to 18.09%, making it a notable source of protein for individuals following a diet high in protein. In addition, the moisture content ranges from 10.7% to 11.8%, while the ash content varies from 1.52% to 3.52%. The carbohydrate content is found to be between 56.91-59.12g/100g, the dietary fibre content between 10.69-13.00g/100g, and the fat content between 1.63-1.67g/100g. Kavılca bulgur contains varying amounts of B vitamins and minerals. Notably, it is particularly abundant in iron, zinc, phosphorus, potassium, and magnesium (Demir, 2020).

Kavılca is also recognised as an important agricultural heritage product for its capacity to thrive in harsh climatic conditions. Kavılca flour is obtained from Kavılca (*Triticum dicoccom*), one of the oldest wheat varieties in the world and an ancient grain native to the Ardahan region in northeastern Turkey (Dhanavath and Rao 2017; Yüksel 2018; Çetinkaya & Gülbaz 2022). This wheat variety has been cultivated for over 10,000 years and is famous for resisting harsh climatic conditions (Mısır and Alp Baltakesmez, 2024). Kavılca flour is a rich source of dietary fibre, contains low levels of gluten and is a good source of many essential nutrients, including B vitamins, zinc and magnesium (Atak 2017). These characteristics make it a highly nutritious option for use in baking. The distinctive, nutty flavor and dense texture of this grain contribute to the revival of traditional breads and culinary heritage in Turkey. This ancient grain has gained renewed interest due to its role in sustainable agriculture and biodiversity. It is now seen as an important element in the transition to healthier and more environmentally friendly food systems.

Geographically indicated products, also known as Geographical Indication (GI), serve to emphasise the unique qualities of goods linked to specific regions. Facilitating product development in this area is crucial as it supports local economies, improves product differentiation and guarantees the protection of cultural heritage (Checchinato et al., 2024). The development of these products can facilitate increased marketability, tourism attraction and the creation of a distinct identity in global markets. Furthermore, this development ensures quality control, strengthens legal protection and promotes sustainability, thus helping regions to maintain their economic and cultural heritage over time (Barham, 2023).

Hatay Kömbe cookie, which has a geographical indication, is a type of sweet cookie that is baked after being shaped in traditionally produced wooden moulds (İflazoğlu & Aksoy, 2024). It is characterised by a distinctive spice dough composition that pice mixture consists of powder cinnamon, allspice, clove, muscat, ginger, mahaleb and mastic gum (Turkish Patent, 2024). The dough used in the preparation of Hatay Kömbe cookie is characterised by its reduced stickiness and cinnamon in the mixture is responsible for the brown colour of its.

In this study, two products with geographical indications (CGIs) were used. The first of these is Ardahan Kavılca Flour and the other is Hatay Kömbe cookies. The objective of this research was to produce cookies with enhanced physicochemical attributes and sensory properties using Kavılca flour prepared with belong to group of Emmer wheat, and was conducted to assess to evaluate consumer acceptance of the cookies produced from Kavılca flour. For this purpose, the effect of production with Kavılca flour on the properties of cookies such as color, browning index (BI), and baking weight loss (BWL), as well as the changes in textural properties such as hardness and brittleness, which are greatly affected by low gluten content, were examined. In addition, the changes in the fatty acid profile of the cookies at the initially and end the 2 month were determined. Apart from these features, sensory properties of the cookies at the initially, the 1st month and at the end of the 2nd month were determined.

Material and Methods

Raw materials

Kavılca wheat flour used in cookie was obtained from a local flour mill in Ardahan. Other food ingredients used in the production were obtained from the domestic market. The mould used to shape the cookie was obtained from a local business in Hatay. All food materials were stored in Ardahan University Food Microbiology Laboratory. As demonstrated in Table 1 and Table 2, Ardahan Kavılca wheat and white wheat can be distinguished by a number of key characteristics.

Table 1. Quality Characteristics of Ardahan Kavılca Wheat and White Wheat

Characteristic	Ardahan Kavılca Wheat	White Wheat
Hulled hectoliter weight (kg/hL)	47.7–52.5	49.7–54.5
Dehulled hectoliter weight (kg/hL)	74.1–77.4	76.0–81.0
Thousand kernel weight (g)	28.0–31.1	35.0–45.0
Hardness (%)	68.0–74.6	60.0–70.0
Diameter (mm)	2.64–2.79	2.5–3.5
Grain protein content (%)	10.03–12.32	8.0–11.0
Ash content (%)	1.78–1.95	0.55–0.60
Wet gluten (%)	24.4–33.2	27.0–31.0
Dry gluten (%)	8.2–12.3	9.0–11.0
Flour yield (%)	61.9–65.0	70.0–75.0

Table 2. Mineral Contents of Ardahan Kavılca Wheat and White Wheat

Mineral	Ardahan Kavılca Wheat	White Wheat
Zinc (mg/kg)	31.81–39.99	35.2–39.0
Iron (mg/kg)	27.45–30.90	40.6–46.6
Calcium (mg/kg)	309–341	408–450
Magnesium (mg/kg)	1053–1147	1656–1800
Potassium (mg/kg)	3920–4318	4860–5000
Selenium (mg/kg)	0.021–0.077	84.84–90.0

Methods

Cookie Production Process

In the initial stage of the process, the ingredients, namely margarine, oil, milk, water, powder sugar and baking powder, were combined in a large bowl for approximately ten minutes. Subsequently, the flour and spice mixture were incorporated gradually, which was mixed for a further five minutes (Table 3). Subsequently, the dough was refrigerated for 24 hours at a temperature of 4°C. Subsequently, the dough was divided into six equal portions of 60 grams each. The cookies were shaped using a mould, and the shaped of the cookies, referred to as "Kömbe," were dipped in 10 grams sesame seeds and placed on a baking tray. The requisite technological parameters for mixing, resting, and baking are presented in Table 3. The prepared cookies were baked in an oven set to a temperature between 160 and 180˚C for a duration of 25 to 30 minutes. The samples were stored in a cool and dry environment at 21˚C. Each batch of cookies was produced one day before the laboratory and sensory analyses.

Table 3. Spices and quantities used in Hatay Kömbe Cookie (for 100 g)

Spices	Amount (gram)
Mastic Gum	5
Muscat	6
Ginger	6
Mahaleb	6
Powder Cinnamon	23
Allspice	23
Clove	23

The production process of Hatay Kömbe cookies with GI (Registration No: 1173) is outlined in Table 4 and Figure 1 (Turkish Patent, 2024). As illustrated in Table 5 and Table 6, the samples of cookies were labeled (a group with Kavılca) HKK with Kavılca (100%) and (a control group) HKW without Kavılca (0%).

Figure 1. Hatay Kömbe Cookie Production with Kavılca flour (HKK) and White flour (HKW)

Table 4. Ingredients and technological parameters used in the preparation of Hatay Kömbe Cookie

Ingredients(g)	Kömbe (Cookie) Samples*	
	HKW	HKK
Wheat Flour (WF)	100	-
Kavılca Flour (KF)	-	100
Margarine**	35	35
Liquid Oil**	15	15
Powdered Sugar**	25	25
Sodium bicarbonate**	1	1
Milk **	10	10
Water**	10	10
Susame**	10	10
Kömbe (cookie) Spices**	1.8	1.8
Technological Parameters		
Mixing time (min)	15	15
Dough Temperature (˚C)	21˚C	21˚C
Resting time (hour)	24	24
Temperature (˚C)	3-4˚C	3-4˚C
Baking time (min)	25	25
Temperature (˚C)	170˚C	170˚C

Note: * HKW = 0% kömbe (cookie) with 100% WF (control sample); HKK = kömbe (cookie) with 100% KF; ** The auxiliar materials are reported to 100% of flour blends.

Characteristics of Cookie

Physical Parameters

To determine the Hatay Kömbe cookies (HKCs) baking weight loss, the weight of cookies before and after production was measured using a digital scale. The ratio between the weight of the dough and the cooked and cooled cookies was calculated using the equation (1) given by Krupa-Kozak et al (2020).

$$\text{WL}\ (\%) = \frac{(a-c)x\ 100}{a} \quad (1)$$

(a): The weight of batter in the mould before baking (g); (c): The weight of baked and cooled HKC (g).

Colour Analysis

The measurements of the HKCs were made using a Color Spectrophotometer (Hunterlab

Colorquest XE, USA) based on the CIE-LAB system and the results were expressed by the CIELab system, the values were the mean of at least five replicates. The L* (0=black, 100=white), a* (+red, –green) and b* (+yellow, –blue) color coordinates were determined according to the CIELAB coordinate color space system. Also, the browning index (BI), the whiteness index (WI) was calculated using the equation given by Krupa-Kozak et al (2020).

The whiteness index (WI) of HKCs was calculated according to Equation (2):

$$WI = 100 - \sqrt{(100 - L^*)^2 + a^{*2} + b^{*2}} \quad (2)$$

The browning index (BI) of the HKCs was calculated according to Equations (3) and (4)

$$\mathrm{BI} = \frac{100\mathrm{x}(\mathrm{X} - 0.31)}{0.17} \quad (3)$$

$$\mathrm{X} = \frac{a^* + 1.75L^*}{5.645L^* + a^* - 3.012b^*} \quad (4)$$

Texture Profile Analysis

The hardness and fracturability values of HKCs were determined 24 hours after baking using a three-point bending probe and a 30 kg load cell on a texture analyzer (TA-XT Plus C, Lloyds Instruments, UK) at Central Research Laboratory Application and Research Center of Ardahan University according to the method of Gül et al., (2021). The test parameters on the texture analyzer were set as pre-test speed: 1.0 mm/s, test speed: 3.0 mm/s, post-test speed: 10 mm/s, distance 5.0 mm and data acquisition speed 500 pps.

Determination of the fatty acid profile

The analysis of fatty acid methyl esters (FAMEs) was conducted at the Central Research Laboratory of Ardahan University's Application and Research Centre, utilising Gas Chromatography-mass spectrometry (Thermo Scientific Trace 1300 equipped with an EGC-YA01 column). This method was employed in accordance with the protocol outlined by Kola et al. (2015). In summary, a total of 150 g of biscuits were reacted with 0.1 mol/L NaOH-MeOH for 5 minutes, followed by reaction with 1.1 mol/L HCl-MeOH for 5 minutes at room temperature. The FAMEs were extracted with isooctane after the addition of water to stop the reaction.

Sensory Evaluation

A panel of six experts (two women and four men), previously selected and trained following ISO guidelines (38 amendment), evaluated the sensory properties of the products 24 hours after cooking. The assessors were already conversant with the Kavılca wheat and were aware of the geographical indications Hatay Kömbe and Ardahan Kavılca Wheat. A sensory analysis form, comprising criteria on appearance, colour, texture, taste, odor and general acceptance, was employed to assess the sensory characteristics of the products. The evaluation was conducted using a 5-point Likert-type scale. The products were assigned alphanumeric identifiers (HKK and HKW) and presented to the evaluators in a randomised order on transparent plates. The sensory evaluation was conducted under standard lighting conditions at room temperature (21˚C) in a sensory laboratory room that met the requirements of ISO standards (41 amendment). It was recommended that bottled mineral water be consumed between each sample evaluation to minimise the effects of residue. The sensory analysis was repeated at 0., 1., and 2 months to determine the shelf life of the products.

Statistical Analysis

The experimental design was completely randomised into a control group (HKW) and a group with Kavılca (HKK). Statistical evaluation of sensory analysis results was performed using SPSS 26.0 (SPSS Inc., Chicago, USA). Sensory data were collected in 3 replicates in shelf-life studies. Sensory data were analysed using SPSS software 29 (IBM Corporation, Somers, NY) and differences were determined by ANOVA at a significance level of $P<0.05$. The results of this test were presented in tabular form.

Results and Discussion

In the current work, various physicochemical properties of HKCs were determined (Table 5). One of these was baking weight loss. BWL, defined as the removal of moisture that affects the texture and staling properties of cooked products, is seen as one of the greatest technological losses and therefore efforts are made to minimize it. A porous structure is formed as a result of the evaporation of water during the cooking process. As a result of this situation, a series of physical and chemical changes occur, such as volume increase (Mondal and Datta 2008; Krupa-Kozak et al., 2020). No statistical significance was observed in the BWL of products within the experimental group. However, a discrepancy was identified between the groups. The mean BWL was determined to be 10.34% for the product obtained from HKW and 34.08% for the product produced using Kavılca flour (HKK). WL is mainly due to the drying process. However, during the initial heating process, water evaporation may occur as the crust formation on the product does not occur immediately (Purlis and Salvadori 2009). This situation has been attributed to the low water-retention capacity of the Kavılca. The values obtained at the end of the second month were examined and although a slight decrease was noted, no significant change was observed in either product.

Table 5. The physicochemical and texture properties of HKCs (initial and after 2 months storage) *

	HKW		**HKK**	
Parameter	0	2	0	2
Baking Weight Loss (%) (BWL)	10.34 ± 0.02 ^{aA}	09.32 ± 0.03 ^{bA}	34.08 ± 0.01 ^{aB}	32.11 ± 0.02 ^{bB}
Whiteness Index (WI)	116.50 ± 0.06 ^{aA}	115.60 ± 0.05 ^{bA}	34.08 ± 0.04 ^{aB}	34.12 ± 0.06 ^{aB}
Browning Index (BI)	37.73 ± 0.07 ^{aA}	37.23 ± 0.11 ^{bA}	123.52 ± 0.15 ^{aB}	124.12 ± 0.20 ^{bB}
L*	51.26 ± 0.35 ^{aA}	50.06 ± 0.15 ^{bA}	41.87 ± 0.14 ^{aB}	40.27 ± 0.34 ^{bB}
a*	15.84 ± 0.12 ^{aA}	14.64 ± 0.10 ^{bA}	15.61 ± 0.14 ^{aA}	16.11 ± 0.10 ^{bB}
b*	32.49 ± 0.11 ^{aA}	32.19 ± 0.53 ^{aA}	26.93 ± 0.11 ^{aB}	27.03 ± 0.19 ^{aB}
Hardness (g)	850.13 ± 30.79 ^{aB}	1112.70 ± 38.01^{bB}	409.23 ± 47.30 ^{aA}	601.72 ± 4.07 ^{bA}
Fracturability (mm)	47.72 ± 0.12 ^{aA}	47.79 ± 0.40 ^{aA}	48.97 ± 0.68 ^{aA}	49.86 ± 0.58 ^{aA}

Note: * HKW = 0% Hatay Kömbe cookie with 100% WF (control sample); HKK = Hatay Kömbe cookie with 100% FK Values are means of three independent determinations and standard errors.
'a, b' Different letters in the same row indicate differences among the same samples (P < 0.05).
'A, B' Different letters in the same row indicate differences among groups (P < 0.05).

Colour, which is the first feature by which food is evaluated by the consumer, is used to detect some damage and quality defects in foods. The *L** value determined for the HKK was significantly ($p < 0.05$) lower (*L** value = 41,86) compared with the HKW (51,25). Considering that both products were baked under the same conditions, this result was attributed to the higher protein content of Kavılca flour. Özgören and Işık (2023) compared the color values of commercial white and Kavılca flour in their study, and it was stated that Kavılca was darker in a different way. Also, the same result determined that in a* and b* values of Kavılca flour. In the present study, at the end of production, the a* value representing redness and greenness did not differ between HKK and HKW, while the b* value representing yellowness and blueness was found to be higher in HKW (Table 2).

The browning index is defined as a simple indicator of a chemical change and/or colour change due to oxidation of the surface of a freshly cut fruit or vegetable during storage or drying or baking of bread. For HKW, WI was determined as 116.50 while BI was determined as 37.73. In HKK, WI was determined as 34.08 while BI was determined as 123.53. These results were attributed to; carbonyl groups of reducing sugars produce brown nitrogenous pigments (melanoidins) polymerizing with α-and ε-amino groups of proteins, peptides or amino acids by the Maillard reaction (Starowicz and Zieliński 2019). There was no significant change for either product when looking at the values at the end of the second month, both colour and BI/WI index.

The textural properties of HKCs were measured using TA-TX Plus C texture analyzer (Lloyds Instruments, UK). Textural profile analysis in all the HKCs was performed to evaluate as hardness, and fracturability (Figure 2). Hardness is one of the important parameters for consumer acceptability, especially in products such as cookies (Mohibbullah et al 2023). The general textural properties of these products are related to starch gelatinization as well as sugar content (Silav-Tuzlu and Tacer-Caba 2021). When the hardness property was evaluated in the study, this value of HKW (850.131) was significantly higher than HKK (409.23). Especially in products like biscuits, texture values are in a very wide range. This situation is attributed by researchers to the substances used in the formulation, their amounts and also the water used (Martinez et al 2018; Gül et al 2021). It is stated that the hardness of biscuits made from gluten-free flour such as buckwheat flour increases throughout the shelf life. Kavılca flour is also one of the flours with low gluten content.

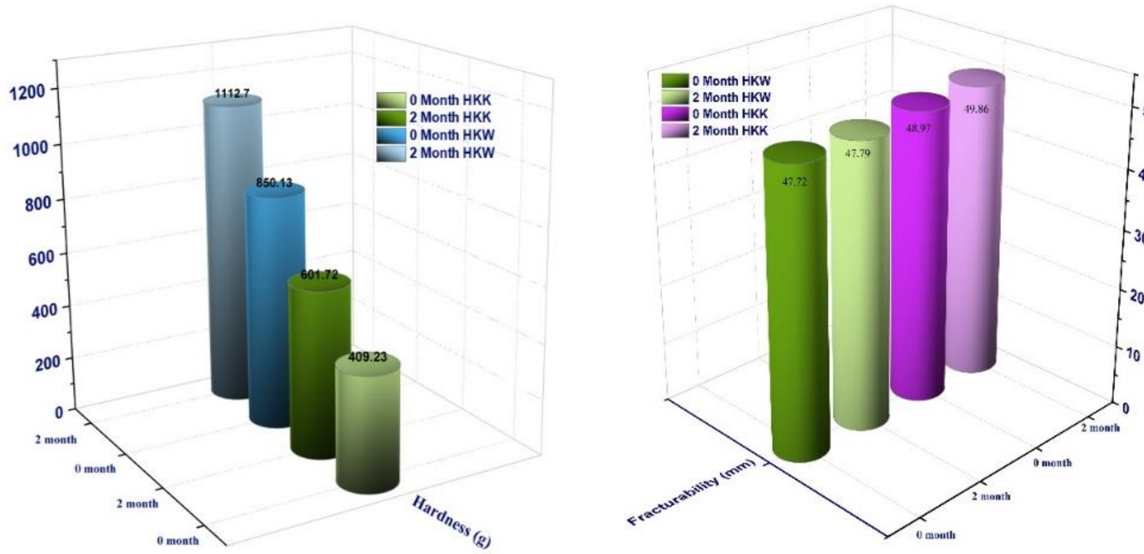

Figure 2. Textural profile in all the HKCs

When the fracturability results of the products were examined; HKW was determined as 47.72 and as HKK 48.97. Gluten is a protein that is important on the main quality and structure of bakery products (Alvarenga et al., 2011), while Kavılca flour is a rich source of dietary fiber but contains low levels of gluten (Atak 2017). These results are more like biscuit varieties made from gluten-free flours (Gül et al 2021; Doğan and Meral 2016; Tüter 2019), and this was attributed to the low gluten protein content of Kavılca. At the end of the 2-month period, it was determined that the hardness value of HKK increased to 601.72, the fracturability value was determined as 49.86. These values for HKW were determined as hardness 1112.70 and fracturability 47.79.

In the study by Arslan-Unal and Ozkaya (2025), various types of flours were utilised in the production of cookies, and a comparative analysis was performed on their respective textural properties. The study concluded that higher proportions of whole flour resulted in cookies with higher hardness. The highest breaking strength (11.9kg) was observed in cookies made from flours with high gluten content, while cookies made from 100% Kavlıca flour exhibited the lowest breaking strength (4.9kg). This was attributed to the dilution of the gluten content available to bind water and the weak gluten structures of ancient wheat. A study was performed to examine the relationship between cookie hardness and protein quality. It was reported that the higher breaking strength of cookies obtained using 100% whole flour was due to the high-water absorption capacity of bran. Furthermore, it was determined that cookie hardness depends on protein and gluten quality (Hidalgo et al., 2019; Saka et al., 2020). In present study, the HKK exhibited a softer texture and higher fracturability compared to the HKW, and these results are like those of Arslan-Unal and Ozkaya (2025).

An investigation was conducted into the fatty acid profile of cookies produced using Kavılca flour, to provide potential insights into the beneficial health effects. The fatty acid methyl esters and various compounds contents of HKCs after the first production and 2-months are shown in Table 6. The most abundant fatty acid methyl esters were determined as hexadecanoic acid, methyl ester (31.92%) in HKK, followed by 9 octadecenoic acid, methyl ester (33.07%), 9,12 octadecadienoic acid, methyl ester (23.37%), and octadecanoic acid, methyl ester (7.91%). It is important to note that essential fatty acids are those which the human body is unable to synthesize and thus they must be obtained from external sources through the consumption of nutrients.

Table 6. Fatty acids and methyl esters composition of the HKK and HKW cookies*

			HKK		**HKW**	
			Time (month)			
			0	**2**	**0**	**2**
Compound Name	**Chemical Group**	**Molecular Formula**	**Area %**	**Area %**	**Area %**	**Area %**
Octanoic Acid	Saturated Fatty Acid	C9H18O2	0.09	0.17	0.04	0.05
Hexanoic acid	Saturated Fatty Acid	C7H14O2	0.04	0.03	-	-
Heptanoic Acid	Saturated Fatty Acid	C7H14O2	-	0.03	-	-
Dodecanoic Acid	Saturated Fatty Acid	C12H24O2	0.05	0.05	0.03	0.03
Heptadecanoic Acid	Saturated Fatty Acid	C17H34O2	0.04	0.05	0.02	0.03
Eicosanoic Acid	Saturated Fatty Acid	C20H40O2	0.04	0.04	0.05	0.06
1,2,3-Propanetriol	Glycerine	C3H8O3	-	0.77	-	0.57
Hexanoic Acid, Methyl Ester	Fatty Acid Methyl Ester	C7H14O2	0.03	-	-	-
Phenol, 2-Methoxy-4-(2-Propenyl)- (eugenol)	Phenol	C10H12O2	-	0.07	-	-
Benzoic Acid,3,4,5 Trihydroxy, Propyl Ester	Ester	C10H12O5	-	-	0.02	-
Phenol, 2-Methoxy-5-(1-Propenyl)-, (E)-	Phenol	C10H12O2	-	-	-	0.01
Decanoic Acid, Methyl Ester	Fatty Acid Methyl Ester	C11H22O2	0.16	0.07	0.05	0.03
Dodecanoic Acid, Methyl Ester	Fatty Acid Methyl Ester	C13H26O2	1.82	1.08	0.43	0.36
Heptaethylene Glycol	Ether	C14H30O8	0.50	-	0.30	0.29
Cycloheptasiloxane, Tetradecamethyl	Ether	C14H42O7Si7	-	-	0.10	-
Dodecane, 2,6,10 Trimethyl	Terpenes	C15H32	0.02	-	-	-
Tetradecanoic Acid, Methyl Ester	Fatty Acid Methyl Ester	C15H30O2	2.22	1.26	1.81	1.69
Trans-Caryophyllene	Terpenes	C15H24	-	-	-	0.03
Benzoic Acid,2,4bis[(Trimethylsilyl)Oxy] Trimethylsilyl Ester	Ester	C16H30O4Si3	0.01	-	-	0.02
Hexadecanoic Acid, Methyl Ester	Fatty Acid Methyl Ester	C17H34O2	31.92	27.67	32.32	31.88
Octanoic Acid, Methyl Ester	Fatty Acid Methyl Ester	C18H38O5	0.17	0.09	0.05	0.04
2,2,3,3,4,4 Hexadeutero Octadecanal	Ester	C18H30D6O	0.01	-	-	-
Methyl 9,10 Methylenehexadecanoate	Fatty Acid Methyl Ester	C18H34O2	0.05	-	0.06	-
Heptadecanoic Acid, Methyl Ester	Fatty Acid Methyl Ester	C18H36O2	0.20	-	0.51	-
Dodecachloro-3,4-Benzophenanthrene	Unknown	C18Cl12	-	0.22	-	-
Octadecane, 6 Methyl	Hydrocarbons	C19H40	0.01	-	-	-
Octadecanoic Acid, Methyl Ester	Fatty Acid Methyl Ester	C19H38O2	7.91	0.45	7.88	6.99
9 Octadecenoic Acid, Methyl Ester	Fatty Acid Methyl Ester	C19H36O2	33.07	32.05	30.10	31.73
9,12 Octadecadienoic Acid, Methyl Ester	Fatty Acid Methyl Ester	C19H34O2	23.37	15.56	21.34	20.09
9,12,15 Octadecatrienoic Acid, Methyl Ester,	Fatty Acid Methyl Ester	C19H32O2	0.48	0.25	0.46	0.38
Eicosanoic Acid, Methyl Ester	Fatty Acid Methyl Ester	C21H42O2	0.74	-	0.92	0.62
Cis11eicosenoic Acid, Methyl Ester	Fatty Acid Methyl Ester	C21H40O2	0.40	-	0.39	-
Methyl 9-Eicosenoate	Fatty Acid Methyl Ester	C21H40O2	-	-	-	0.29
Docosane	Hydrocarbons	C22H46	0.01	-	-	-
Octaethylene Glycol Monododecyl Ether	Ether	C28H58O9	0.46	1.44	-	0.76

Note: * HKW = 0% Hatay Kömbe cookie with 100% WF (control sample); HKK = Hatay Kömbe cookie with 100% FK Values are means of three independent determinations and standard errors.

The fatty acids are α-linolenic acid (ALA, 18:3), which has 18 carbons and 3 double bonds, and linoleic acid (LA, 18:2), which contains two double bonds (Çelebi et al., 2017). When LA and ALA are ingested with food, arachidonic acid (20:4 n-6) can be synthesised from linoleic acid, which cannot be synthesised in mammals, by elimination (lengthening of the carbon chain) and desaturation (increase in the number of double bonds). Also, n-3 series fatty acids such as eicosapentaenoic acid (20:5 n-3), docosapentaenoic acid (22:5 n-3) and docosahexaenoic acid (22:6 n-3) can be synthesised from α-linolenic acid (Harris et al 2008; Çelebi et al 2017). Alpha linolenic acid (ALA) is very sensitive to damage from factors such as light, oxygen and heat and is destroyed approximately five times faster than Linoleic acid (LA) (Kaur et al 2014). Omega-6 and omega-3 fatty acids are the form of triglycerides from various food sources digested in the small intestine, absorbed, transported in the blood, and assimilation throughout the body, including the brain, retina, heart and other tissues (Kaur et al., 2014; Paucean et al., 2018).

Fatty acid esters are defined as significant fatty chemicals, which are formed as a result of the reaction of fatty acids with alcohols. Their utilization is highly probable due to their structural properties, and there is a rapid increase in their production and consumption worldwide. Long-chain triacylglycerols (LC-TAGs) are naturally occurring fatty esters that exhibit certain metabolic characteristics (Chiş et al., 2020; Gilbaz 2022). For instance, they are more susceptible to hydrolysis than medium-chain fatty esters (C6 - C12). Additionally, they are utilised in low-calorie diets. In contrast, fatty acid methyl esters (FAMEs) play a critical role in the industry as intermediates, although their direct utilisation remains limited. These esters are increasingly replacing fatty acids as starting materials in various industrial processes (Bogaerts et al., 1990; Kola et al., 2015; Gilbaz 2022).

As demonstrated in Table 6, the analysis revealed that HKK contains higher concentrations of octanoic acid, hexanoic acid, dodecanoic acid, heptadecanoic acid and eicosanoic acid, in addition to a more abundant fatty acid methyl ester, when compared to HKW. Conversely, wheat flour exhibits either an absence or a presence of certain critical fatty acids and esters at minimal levels. In view of these findings, it can be concluded that the use of Kavılca flour during production results in a fatty acid profile that is richer in terms of diversity and concentration. During the shelf life of HKK, losses of hexanoic acid and methyl ester were observed; however, when the detected fatty acids and esters were analysed as a whole, it was determined that they remained relatively stable during storage.

The shelf life of Hatay Kömbe cookie made with white flour (HKW) and Kavılca flour (HKK) was determined according to the results of sensory analysis after 0, 1 and 2 months. It was accepted that the shelf life of both groups was 1 month according to the sensory results. According to this result, it was found that there was a significant decrease in odor, taste, texture and general acceptance in the groups after the first month. With 100% Kavılca flour, the sensory acceptability of the Hatay Kömbe cookies production is quite low. The texture structure of the biscuits produced with Kavılca flour (HKK) was found to be very thin by hand and in the mouth. The taste and aroma of the flour were found to be dominant due to the unique intense nutty taste and smell of the flour. Kavılca flour requires different binders due to the limited gluten content in its structure. The results of the sensory and laboratory analyses support each other. In the study, production with 100% (direct use of the product) Kavılca flour was given priority. However, due to the structure of Kavılca flour, it was found that different mixing processes should be tried during the production of the product (Figure 3 and 4).

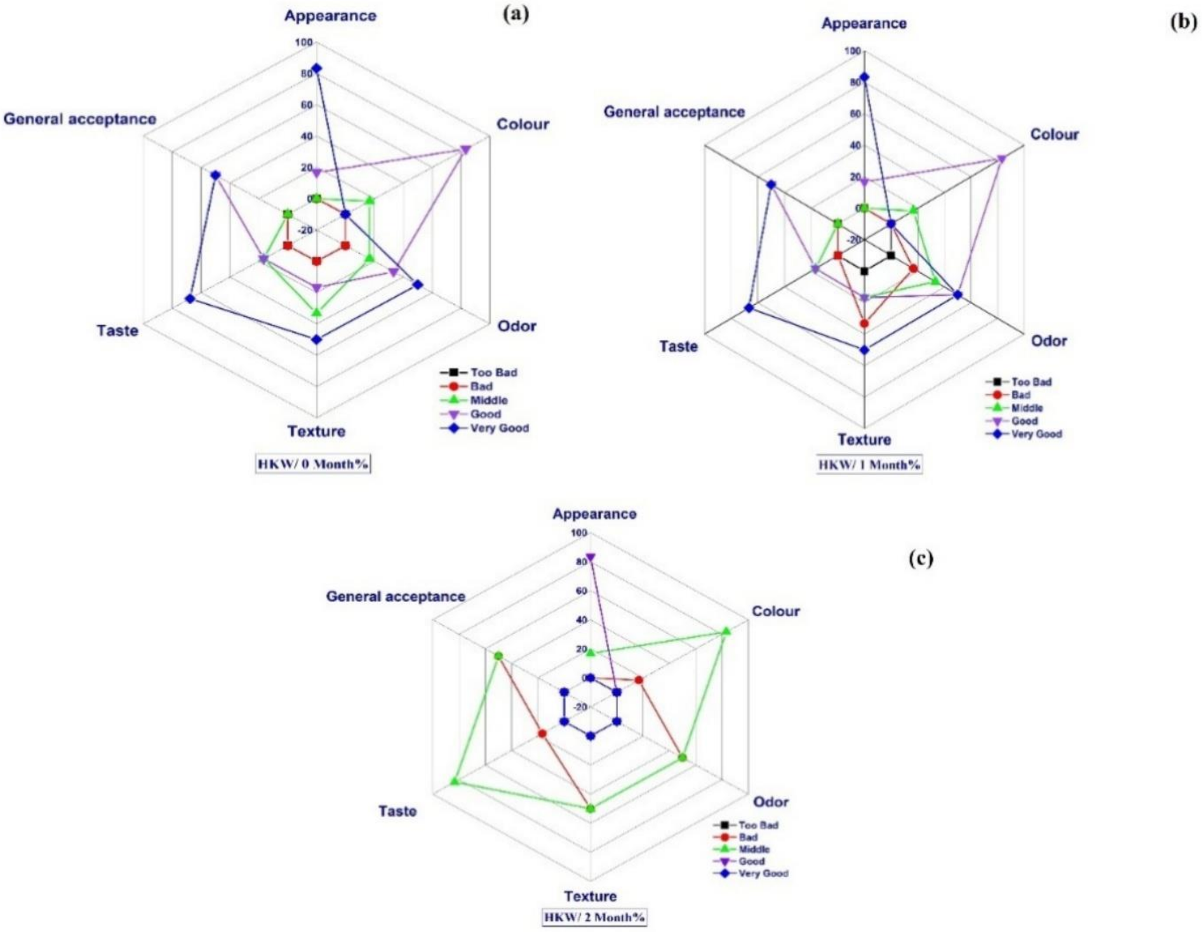

Figure 3. Sensory properties result of the HKW

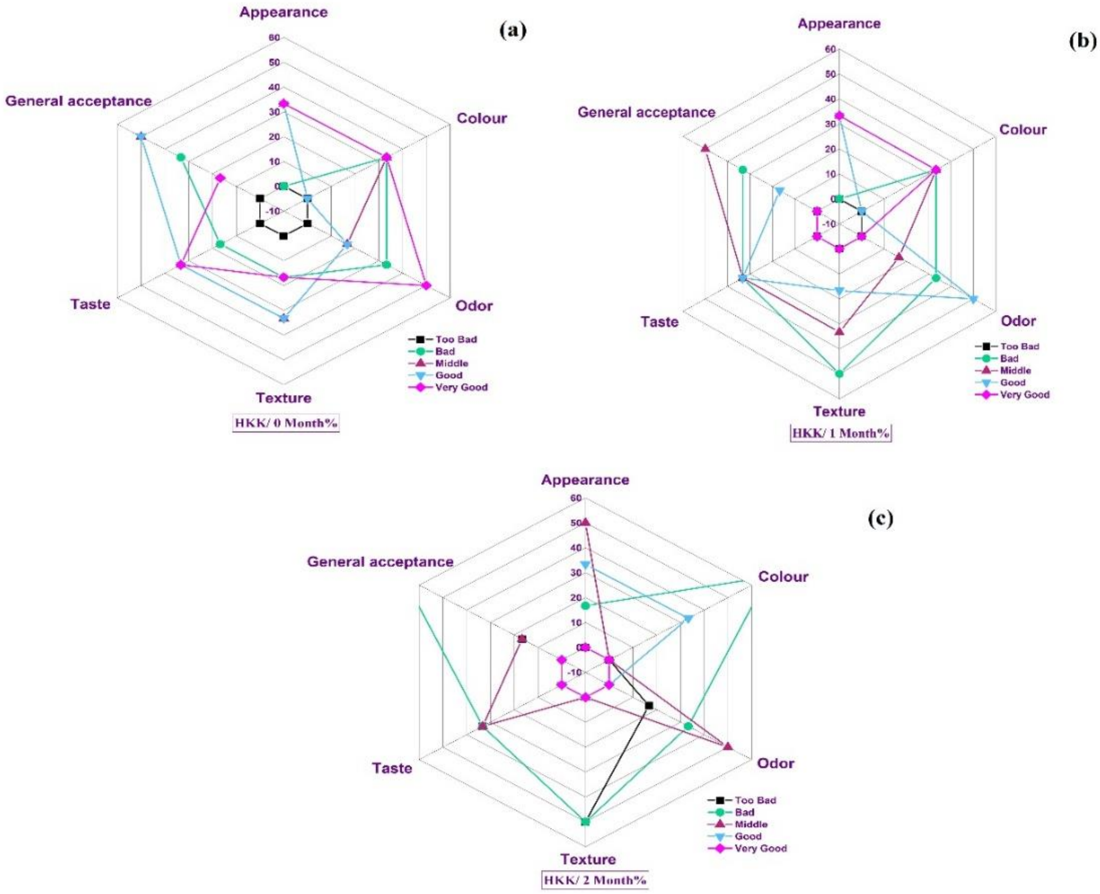

Figure 4. Sensory properties result of the HKK

Conclusion

It is thought that Kavılca wheat, which has low levels of gluten in its structure, will be a natural alternative to new consumption habits. The present study is important in developing and improving the qualities of the products with Kavılca. Kavılca flour, which is rich in terms of nutritional values compared to white flour, has less gluten and is produced from ancestor seed wheat. With these aspects, preparing new recipes with the product is necessary. For this purpose, in the current study, HKCs prepared with various spices and traditional production techniques were prepared with Ardahan Kavılca flour. The results obtained from the analysis of various fatty acids and methyl esters indicated that the cookies (HKK) produced using Kavılca wheat possessed a more substantial composition, thus increasing the nutritional value of the product and contributing to its functionality in terms of health. According to the sensory analysis results, it was determined that HKK was acceptable. However, textural properties affected by gluten content such as hardness were found to be weak. The production of various products with Kavılca flour is a new situation and requires testing different formulations. In this study, Hatay Kömbe cookie was produced with 100% Kavılca flour. However, to improve the textural properties of the product, experiments should be carried out using lower amounts of Kavılca flour.

Declarations

Conflict of interest

The authors declare that there are no conflict of interest.

Author contributions

DAB: Designed study, production of cookies, conducting experiments, data collections and analysis, writing and reviewing the manuscript. **SM**: Designed study, analyzed the data by statistical program, production of cookies, writing and reviewing the manuscript.

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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Data Availability

The dataset generated during and/or analyzed during in the current study are available from the corresponding author on reasonable request.

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