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Development of Halva with Ancient and Modern Flours: A Comparative Study on Quality and Sensory Properties

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ABSTRACT

Traditional halva is a dessert made from flour, sugar and fat that has played a significant role in Middle Eastern and Anatolian cuisines for many years. This study formulated three types of traditional halva using white wheat flour (H158, the control sample), corn flour (H365) and Kavılca (Emmer) flour (H214). The samples were evaluated in terms of their colour, texture, 5-hydroxymethylfurfural (HMF) content and sensory attributes. *L** values showed that H158 exhibited the highest value (57.34), followed by H365 (55.86) and H214 (42.41). A similar trend was observed for whiteness index values: H158 had the highest value (49.17), followed by H365 (43.23), while H214 had the lowest value (38.92). The texture of halva formulations was determined by their hardness values, with H158 being the firmest (215.56 g), followed by H214 (116.54 g) and H365 (85.61 g). It had a much higher HMF level (18.98 mg/L) than H214, H158, and H365 (6.13 mg/L). This can be attributed to the higher protein content of Kavılca flour. Sensory tests showed panelists preferred halva made with white flour. Halva made with corn flour came second, while halva made with Kavılca flour was least popular. Corn flour halva showed a softer texture and acceptable sensory scores, whereas Kavılca flour halva received lower scores in sensory evaluation despite its nutritional content.

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Introduction

In response to evolving human needs and lifestyles, there has been increased interest in functional foods targeting specific physiological functions with added health benefits (Öztürk et al., 2024). Kavılca wheat, notable for its low gluten and high nutrient content (Gliadin 83.4 mg/kg, Gluten 166.8 mg/kg, Phytic acid 1.15 g/100 g, Protein (%) 13.27, Fat (%) 1.46, Ash (%) 1.86, Dietary fiber) Aydar (2022) exemplifies this trend (Alp Baltakesmez & Mısır, 2025, Mısır 2025). Similarly, corn flour, valued for its low gluten and calorie content, has become popular in health-conscious diets (Mısır, 2025a). Wheat is one of the most widely cultivated crops globally, serving as a staple food for approximately 35% of the world's population due to its adaptability, ease of production, and storage (Ayter, 2010; İnce & Çağındı, 2020; Koç, 2023). Wheat flour is rich in carbohydrates, protein, lipids, vitamin B1, niacin, and minerals such as iron, zinc, and magnesium, all of which enhance its nutritional value (Aydar, 2022; Mısır, 2025b). Corn (Zea mays), cultivated for thousands of years, plays a key role in the culinary traditions of the eastern Black Sea region, especially among Laz, Georgian, and Circassian communities. Its flour is widely used in breads, pastries, soups, and desserts, benefiting from its low gluten content and functional properties (Uğurkan & Alyakut, 2020; Aydar, 2022). Kavılca wheat (*Triticum dicoccum* L.), grown mainly in Kars and Ardahan, is characterized by its hard shell, double grain structure, and resilience to harsh climates (Alp-Baltakesmez, 2025; Mısır, 2025c). Its high protein, fiber, and vitamin content contribute to its nutritional value, and its popularity has increased with the rise of organic farming (Demir, 2020; Alp-Baltakesmez, 2025).

Halva is a traditional dessert from Turkish cuisine and is very important in Turkish culture. Special occasions such as religious ceremonies, holidays, weddings and Mevlit celebrations often see this being prepared and consumed. People use helva to symbolise hospitality and strengthen social bonds. The tradition of preparing it is passed down from generation to generation as part of traditional rituals, making halva not just a dessert, but also a form of cultural heritage (Bozagcı, 2023). This study examined three helva types made from corn, wheat, and Kavılca flours, focusing on their textural differences and

nutritional properties, aiming to propose alternatives to conventional helva varieties.

Material and Methods

Raw materials

Three different types of halva were produced using white flour purchased from the market, corn flour sourced from the Espiye district of Giresun, Kavılca flour sourced from Ardahan province, and water, sugar and oil, all of which were also purchased from the market. Each type of flour was used at a ratio of 100% in the production formulas for these halvas. The flours obtained from the market for the research were stored in a cool and dry environment, and no microbial contamination was observed. The flours were subjected to a roasting process at a temperature of approximately 150˚C, resulting in the production of halva.

Methods

Experimental design

Three distinct types of flour (Kavılca, corn and white flour) were used in the study for halva production, with an equal amount of milk, oil and sugar being received by each type.

Halva Production

The halva is produced using a single formulation, but the flour used as a raw material varies. The flours used were 100% Kavılca wheat, 100% corn wheat and 100% white wheat. As shown in Table 1, producing the halva involved a series of material processing steps. First, a liquid ingredient (milk) was homogenised with sugar. Then the preheated fat was added, followed by the flour, and the mixture was roasted at 150˚C for 15 minutes (Yiğit & Ay-yiğit 2023).

Colour Analysis

The measurements were conducted on white flour halva (H158), corn flour halva (H365) and kavılca flour halva (H214) utilising a CIE-LAB-based Colour Spectrophotometer (Hunterlab Colorquest XE, USA). The results were shown using the CIELab system.The values presented here are the averages of at least five repetitions. The L^* (0=black, 100=white) colour coordinates were determined according to the CIELAB colour coordinate system. The a^* (+red, -green) colour coordinates were determined according to the CIELAB colour coordinate system. The b^* (+yellow, -blue) colour coordinates were determined according to the CIELAB colour coordinate system. Furthermore, the browning index (BI) and whiteness index (WI) were calculated using the equation provided by Krupa-Kozak et al. (2020).

The whiteness index (WI) of H158, H214 and H365 was calculated according to Equation (1):

$$WI = 100 - \sqrt{(100 - L^*)^2 + a^{*2} + b^{*2}} \quad (1)$$

The browning index (BI) of H158, H214 and H365 was calculated according to Equations (2) and (3).

$$\mathrm{BI} = \frac{100\mathrm{x}(\mathrm{X}-0.31)}{0.17} \quad (2)$$

$$\mathrm{X} = \frac{a^*+1.75L^*}{5.645L^*+a^*-3.012b^*} \quad (3)$$

Texture Profile Analysis

The textural properties of H158, H214 and H365 were determined 24 hours after cooking using a three-point bending probe (30 kg) and P/20 probe on a texture analyzer (TA-XT Plus C, Lloyds Instruments, UK) at Ardahan University Central Research Laboratory Application and Research Center according to the method of Gül et al. (2021) and Banas et al. (2018), respectively (Figure 2). The test parameters in the texture analyzer for the three-point bending probe (30 kg) were: 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. For the P/20 probe: 2 mm/s compression speed, 20 mm penetration depth and 1 g trigger force. The analysis was carried out in five replicates with a new halva sample each time. The time and force applied by the probe were measured and the instrument automatically recorded the force-time curve.

Hydroxymethylfurfural (HMF) analysis

The hydroxymethylfurfural (HMF) content was determined using a Shimadzu LC20AD model high-performance liquid chromatography (HPLC) system. This system is equipped with a CTO-10AS column oven and an SPD-M20A photodiode array (PDA) detector. The detector wavelength was set to 280 nm for HMF analysis, and this wavelength was selected due to HMF's strong absorption property in the UV region. The analysis was performed based on the method proposed by Gökmen and Acar (1999). A 5 g portion of each halva sample was dissolved in 20 mL of distilled water. From this solution, 5 mL was extracted twice with 10 mL of ethyl acetate (Merck) under continuous stirring for 5 minutes per extraction. The combined organic layers were treated with 2 mL of 1.5% (w/v) sodium carbonate (Na_2CO_3, Merck). After phase separation, the aqueous layer was further extracted with 10 mL of ethyl acetate. All ethyl acetate extracts were pooled, filtered through Whatman Grade 589/3 filter paper, acidified with acetic acid, and evaporated at 40°C.

Table 1. Formulation of halva (corn, Kavılca and white flour)

Ingredients	Kavılca Flour Halva	Corn Flour Halva	White Wheat Flour Halva
Kavılca flour	200 g	–	–
Corn flour	–	200 g	–
White wheat flour	–	–	200 g
Sugar	170 g	170 g	170 g
Butter	100 g	100 g	100 g
Milk	300 ml	300 ml	300 ml
Vegetable oil	30 ml	30 ml	30 ml

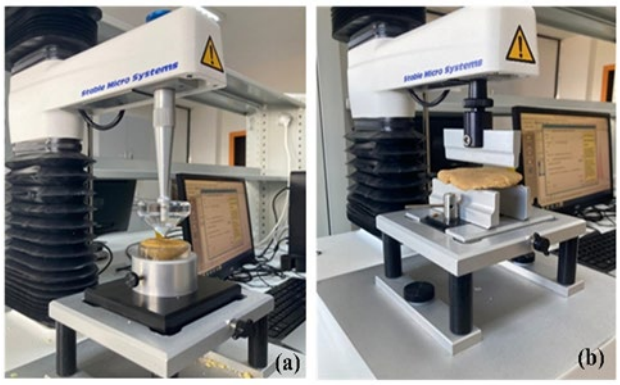


Figure 2. Texture Analyses of Control Group White Flour Halva (a) and Corn Flour Halva (b)

The residue obtained was dissolved in 1 mL of acetic acid (pH 4.0, 20 µL) and analyzed using the HPLC system. Validation data were also taken into account for the analysis. The limit of detection (LOD) for HMF was determined to be between 0.05 and 0.2 µg/mL, in line with the values specified in the literature, and the limit of quantification (LOQ) was determined to be between 0.2 and 0.5 µg/mL. The HPLC system used in the analysis ensures reliable measurement of HMF in a linear range of 1–50 µg/mL.

Sensory Evaluation

The products obtained in the study were evaluated based on their sensory qualities by a panel of 15 participants, which included students and academics from the Department of Gastronomy and Culinary Arts at Ardahan University. The panel consisted of ten students (aged 20–25) currently studying gastronomy and culinary arts, and five academics (aged 30–45) specialising in food science, nutrition, and gastronomy. The sensory characteristics of the products were evaluated by a panel of experts who had undergone training in accordance with ISO guidelines (38 revisions). We conducted this evaluation 24 hours after we cooked the products. The evaluators were familiar with Kavılca wheat and were aware of the Ardahan Kavılca wheat geographical indications. A sensory analysis form was used to evaluate the sensory characteristics of the products. This form covered appearance, colour, texture, taste, aroma and overall acceptance. The evaluation used a 5-point Likert-type scale. The products were given alphanumeric identifiers (H158, H158 and H365) and presented to the evaluators in a random order on transparent plates. The sensory evaluation was conducted in a sensory laboratory room that met the ISO standards (41 revisions), at a temperature of 21°C and under standard lighting conditions. To reduce carryover effects, it was suggested that bottled mineral water be drunk between each test of the samples.

Results and Discussion

Consumers perceive colour as one of their fundamental sensory characteristics. It is also a significant indicator of food quality, freshness and acceptability (Pathare et al., 2013). In this study, instrumental colour parameters (L^*, a^*, b^*) and derived indices such as the Whiteness Index (WI) and Browning Index (BI) were evaluated (Table 2, Figure 3). The aim was to investigate visual quality and pigment transformations during the preparation of halva from different flours. Significant variations in the lightness (L^*) values of the halva samples were exhibited depending on the type of flour utilised ($p<0.05$). The highest L^* value (57.34) was recorded in sample H-158, which was made with white wheat flour, followed by sample H-365 (55.86). Conversely, H-214 had the lowest lightness value (42.41). These results suggest that ancient wheat flours, such as Kavılca, may result in a darker final product due to the grain's intrinsic pigmentation or more intense Maillard browning reactions. This is consistent with previous research which showed that flours with a higher pigment content tend to produce darker final products (Kiliccek & Hepsağ, 2010). The H-365 sample had the highest red-green coordinate (a^*) value (11.08), indicating more intense red hues in corn flour-based halva. Similarly, the maximum value for the yellow-blue component (b^*) was 33.95 in H-365, indicating the most intense yellow hue among all the samples examined. These results can be attributed to two factors: firstly, the natural carotenoid content of corn and, secondly, the yellow-brown Maillard pigments formed during roasting (Chung et al., 2009).

The Whiteness Index (WI), which reflects perceived whiteness, exhibited a comparable trend to L^* values. The whitest appearance was found in H-158 (49.17), followed by H-365 (43.23), while H-214 had the lowest WI value (38.92). These findings suggest that white wheat flour contributes to a lighter and visually more acceptable product for consumers who prefer brighter tones, while the darker tone of H-214 may be attributed to higher pigment concentrations and different protein-sugar interactions during heating (Kılınççeker & Hepsağ, 2010). The Browning Index (BI) is a widely utilised metric for the prediction of non-enzymatic browning, a process that occurs as a consequence of thermal treatments such as drying or roasting (Rannou et al., 2016). Among the samples, H-214 demonstrated the highest BI value (35.29), thereby confirming intense browning during the processing stage. The darker colour observed can be attributed to the formation of melanoidins, which are brown, nitrogen-containing polymers that result from Maillard reactions between reducing sugars and amino acids (Starowicz & Zieliński, 2019). In contrast, H-158 and H-365 exhibited comparable and comparatively reduced BI values, suggesting a less pronounced browning reaction. When the hue and chroma values obtained in the study were examined, it was found that the chroma value, which expresses vividness, was significantly higher in H365. The lowest value was obtained in H214, with H158 following it. H365 displayed a more yellow hue in comparison to the other samples, indicating a higher value for the h parameter, which is used to measure the tone angle. It was not surprising that this value was obtained in the sample made from corn flour, which is a common occurrence in such experiments.

The findings of this study suggest that the type of flour employed is a critical factor in the colour characteristics of halva, which is an important consideration when selecting the correct flour for the best results. Using white wheat flour produces lighter and whiter products, whereas corn flour yields vibrant yellowish-red tones. Furthermore, ancient wheat varieties such as Kavılca tend to produce darker, more intensely browned samples. The high protein content of Kavılca is the reason for this situation, as it has a higher Millard reaction compared to other helvas.

Table 2. Colour analyses results for halva

Parameters	H158	H214	H365
*L** (Lightness)	57.34 ± 0.03[a]	42.41 ± 0.02[c]	55.86 ± 0.03[b]
*a** (Red-Green)	9.41 ± 0.02[c]	9.67 ± 0.01[b]	11.08 ± 0.02[a]
*b** (Yellow-Blue)	25.99 ± 0.03[b]	17.43 ± 0.03[c]	33.95 ± 0.01[a]
C* (Chroma)	27.64 ± 0.02[b]	19.93 ± 0.03[c]	35.72 ± 0.02[a]
h ^{0} (Hue)	70.10 ± 0.02[b]	60.87 ± 0.02[c]	71.91 ± 0.01[a]
Whiteness Index (WI)	49.17 ± 0.05[a]	38.92 ± 0.05[c]	43.23 ± 0.02[b]
Browning Index (BI)	11.76 ± 0.03[c]	35.29 ± 0.04[a]	11.86 ± 0.04[b]

Note: H158 = Wheat flour halva (control group), H214 = Kavılca flour halva, H365 = Corn flour halva. The values represent the means and standard errors of three independent measurements. Different superscript letters (a, b, c) in the same row indicate statistically significant differences between samples ($p < 0.05$).

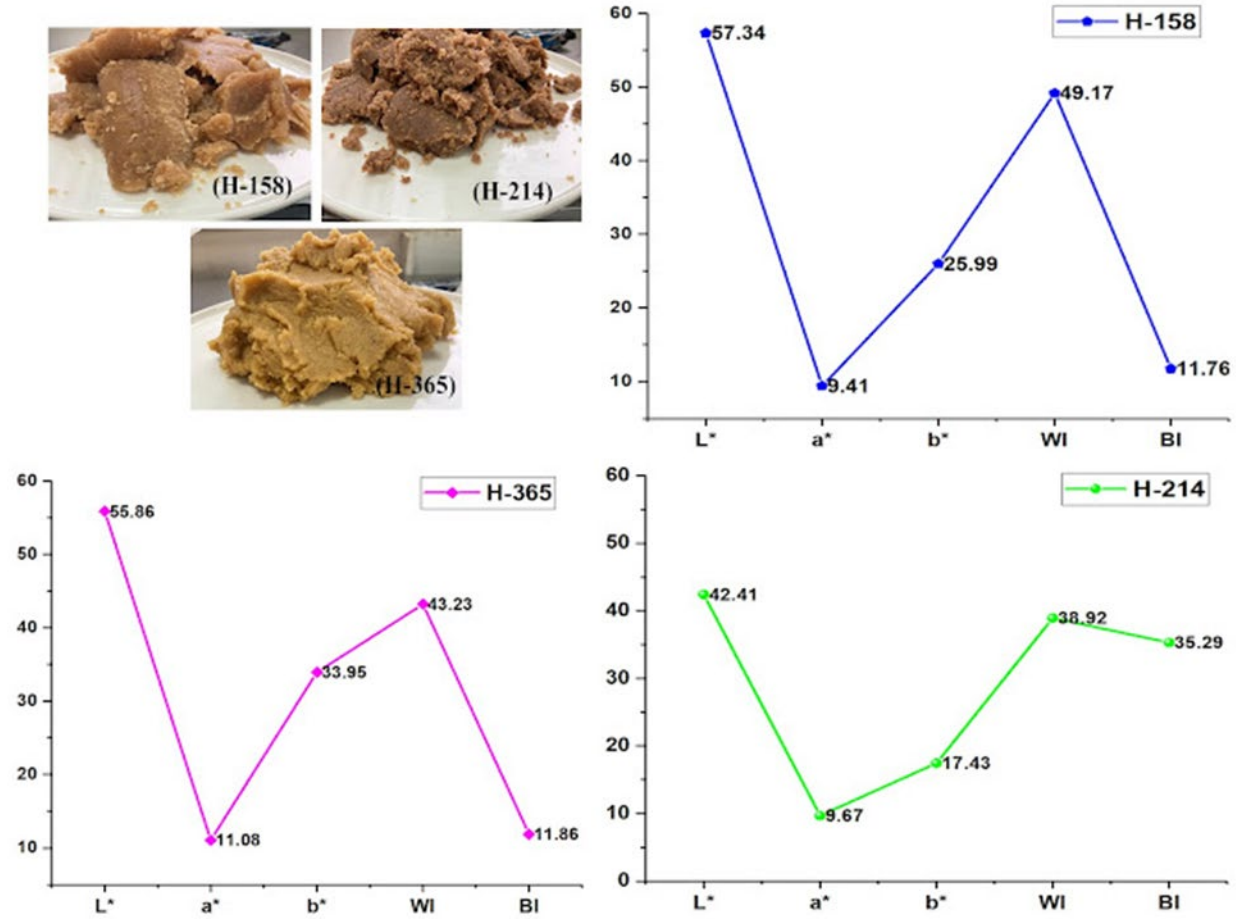


Figure 3. Colour and Visual Characteristics of Halva Samples Produced with Different Flours

Textural properties are critical parameters in determining consumer acceptance, especially for semi-solid traditional desserts like halva. In this study, the texture profile of halva samples was evaluated using a TA-TX Plus-C texture analyser (Lloyd Instruments, UK). In order to achieve the objective of this study, a rigorous experimental approach was adopted. This entailed the use of two distinct test probes: firstly, a three-point bending probe, the purpose of which was to ascertain the elasticity, cohesiveness, hardness, gumminess, and chewiness of the samples; and secondly, a P/20 cylindrical probe, the purpose of which was to evaluate the brittleness and spreadability of the samples (Figure 4). Among the evaluated parameters, hardness emerged as a key attribute due to its strong correlation with consumer preference. The hardness values of the samples varied significantly depending on the flour type: H-158 (white wheat flour) exhibited the highest hardness (215.559 N), followed by H-214 (Kavılca flour; 116.536 N), while H-365 (corn flour) showed the lowest (85.612 N). These findings indicate that halva made with ancient wheat varieties like Kavılca exhibits firmer texture compared to corn-based formulations. The structural firmness of white wheat flour-based samples is likely due to its higher gluten content, which supports a denser and more cohesive network, thus increasing resistance to deformation (Lucisano et al., 2012).

In contrast, corn flour, being naturally gluten-free, yields softer and more friable textures, which has also been noted in studies involving gluten-free wafers and cakes (Mert et al., 2015). Additionally, Özkaya & Özkaya (1992) reported that corn flour's low gas retention capacity can contribute to compact product structures, further lowering the textural integrity during mechanical testing.

Table 4. Textural Properties of Halva Samples Produced with Different Flours

	H158	H214	H365
Hardness	215.559 ± 0.09[a]	116.536 ± 0.06[b]	85.612 ± 0.05[c]
Adhesiveness	-541 ± 0.11[a]	-1.295 ± 0.03[b]	-2.978 ± 0.04[c]
Springiness	0.658 ± 0.07[a]	0.611 ± 0.09[b]	0.472 ± 0.05[c]
Cohesiveness	0.498 ± 0.02[a]	0.478 ± 0.01[b]	0.349 ± 0.01[c]
Gumminess	105.751 ± 0.09[a]	55.603 ± 0.05[b]	29.839 ± 0.07[c]
Chewiness	69.364 ± 0.07[a]	34.014 ± 0.05[b]	14.091 ± 0.04[c]
Resilience	0.239 ± 0.03[a]	0.194 ± 0.04[b]	0.136 ± 0.06[c]
Firmness	229.67 ± 0.09[a]	193.15 ± 0.07[b]	114.09 ± 0.05[c]
Work of shear	25.69 ± 0.05[a]	20.28 ± 0.06[b]	10.43 ± 0.05[c]

Note: H158 = White wheat flour halva (control group), H214 = Kavılca flour halva, H365 = Corn flour halva. Values are expressed as means ± standard error (n = 3). Different superscript letters (a, b, c) within the same row indicate statistically significant differences between the samples ($p < 0.05$).

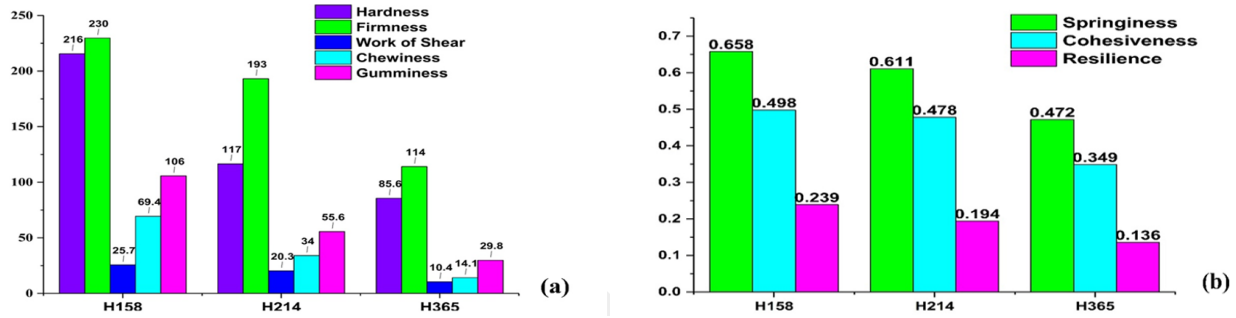


Figure 4. Texture Analysis of Halva Samples

As illustrated by the elasticity values, this tendency was also reflected in the data: H-158 exhibited the highest elasticity (0.239), followed by H-214 (0.194), and the lowest value was observed in H-365 (0.136). Consistent findings were reported by Köten and Ünsal (2021), who established that increases in corn flour content in sponge cakes resulted in diminished elasticity. This reduction was attributed to the absence of gluten, which limits the formation of elastic protein networks. Therefore, while corn flour augments yellow colouration and mitigates the firmness of halva products, it concomitantly compromises the elasticity and structural cohesion of said products.

Gluten is recognised as a key protein affecting the structure and quality of bakery and confectionery products. Its ability to form viscoelastic networks under hydration and mechanical work plays a crucial role in gas retention, volume development, and textural stability. In this study, halva produced from white wheat flour (gluten-rich), Kavılca flour (low-gluten ancient wheat), and corn flour (gluten-free) demonstrated a gradient of textural responses directly associated with their gluten content. Parameters such as hardness, chewiness, and brittleness were significantly enhanced in gluten-containing formulations. The findings, when considered collectively, provide significant evidence that the protein composition and flour type have a substantial influence on the texture of halva, particularly withregard to structural strength and elastic recovery during deformation.

5-Hydroxymethylfurfural (HMF) is a compound that is formed when sugars, such as fructose, are heated. It can also be formed during the Maillard reaction and various processing methods, such as baking, pasteurisation and caramelisation (Capuano & Fogliano, 2011). The utilisation of hydroxylamine (HF) as a chemical indicator of excessive thermal processing in carbohydrate-rich foods has been comprehensively documented (Uzunlu & Herken, 2016). The presence of HMF is usually linked to the later stages of the Maillard reaction, which can result in the creation of undesirable compounds.

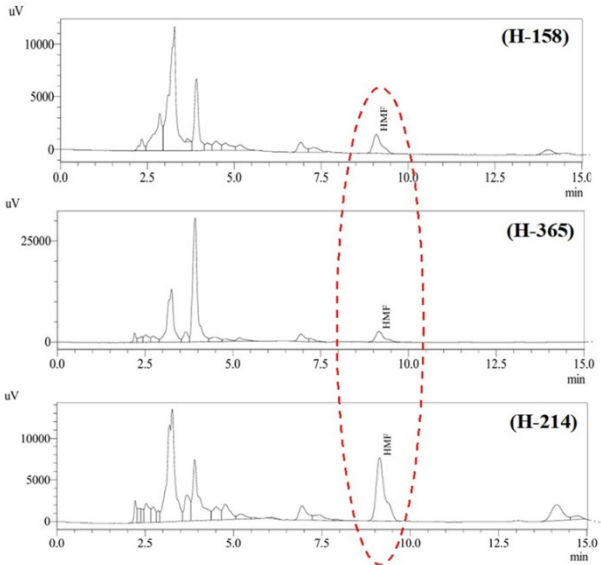
The present study was conducted with the objective of measuring the concentrations of HMF in halva samples that had been prepared using a range of different flours. The HMF content in the white wheat flour sample (H158) was ascertained to be 6.13 mg/L, while a slightly elevated value 7.97 mg/L was obtained for the corn flour sample (H365). However, a considerably higher HMF concentration of 18.97 mg/L was documented in the Kavılca flour-based sample (H214), indicating a statistically significant discrepancy ($p<0.05$). The heightened HMF level in sample H214 may be ascribed to the high protein content of ancient wheat varieties, such as Kavılca, which has been shown to promote the Maillard reaction during thermal processing. As demonstrated in the study by Rufián-Henares & Morales (2007), the reaction between amino groups from proteins and carbonyl groups from reducing sugars under heat conditions results in the formation of HMF as an intermediate product. In addition, a strong relationship was established between the BI and HMF values across the entire sample population. The highest values for BI and HMF were recorded in the Kavılca flour sample. This finding suggests that HMF formation may serve not only as an indicator of the heat load, but also of advanced pigment formation in Maillard reaction pathways (Pastoriza de la Cueva et al. 2017). This finding corroborates earlier research which reported a favourable correlation between the extent of browning in thermally processed carbohydrate-protein systems and the accumulation of HMF.

Research has demonstrated that moderate levels of HMF can facilitate the development of flavour and colour in confectionery products. However, it is noteworthy to observe the potential risks associated with the consumption of excessive amounts, particularly in highly processed foods. Such intake has been associated with potential

health implications including, but not limited to, cytotoxicity and genotoxicity, as evidenced by the research of Evdokimov et al., in (2015). It can therefore be deduced that the necessity for the monitoring of HMF concentrations is paramount for maintaining the quality and safety standards of traditional foods, such as halva (a sweet confection made from semolina). As demonstrated in Figure 5, the HMF results for halva samples highlight significant differences between the three types of flour.

The sensory evaluation in this study was designed to assess both consumer preference and general acceptability of halva samples produced with different types of flour. Furthermore, the results were correlated with physicochemical and textural analyses to ascertain the correlations or inconsistencies between instrumental data and consumer perception. The sensory characteristics evaluated included colour, odour, texture, taste, aroma, mouthfeel, and overall acceptability. In the present study, an investigation was conducted into the characteristics of various types of halva. The results of the study indicated that corn flour-based halva (H-365) received the highest score, followed by white wheat flour (H-158) and Kavılca flour (H-214). This outcome is consistent with instrumental colour values, particularly the higher *b** and Whiteness Index (WI) in H-365, which may be perceived as visually appealing due to its golden colour and familiar appearance (Pathare et al., 2013). With regard to texture and odour, the H-158 and H-365 samples received the highest ratings. This phenomenon can be attributed to consumers' familiarity with white wheat flour halva, which is characterised by its gluten content, which contributes to a more cohesive and elastic texture. The role of gluten in maintaining the desired crumb structure and improving mouthfeel in traditional products has been well documented (Lucisano et al., 2012). It is interesting to note that, despite exhibiting lower instrumental values for hardness and chewability, H-365 received sensory scores that were comparable to those of H-158 in terms of taste, aroma, and mouthfeel. This finding indicates that consumers may exhibit a preference for softer, melt-in-the-mouth textures in halva, irrespective of technical hardness measurements (Szczesniak, 2002). The results of the overall acceptability scores indicated that H-158 and H-365 were the two most preferred samples, while H-214 (Kavılca flour) received the lowest scores in most sensory parameters. The relatively unfamiliar taste and denser texture of the ancient grain-based halva may have influenced this result. This finding is consistent with the conclusions of earlier studies, which suggested that consumers may require an adjustment period to acclimatise to the unique sensory characteristics of ancient grains. The panelists, who were composed of healthy adult individuals, generally expressed a preference for halva made from traditional white wheat flour, followed by the corn flour sample. Despite the growing interest in ancient grains due to their health benefits, Kavılca flour halva was the least preferred halva. This outcome is consistent with the texture and HMF results, which reflect more pronounced Maillard browning and structural variation (Figure 5).

The present findings serve to reinforce the notion that consumer familiarity, visual appeal, and mouthfeel are the primary determinants of sensory acceptability in traditional confectionery. Furthermore, the importance of balancing nutritional innovation (e.g., ancient grains) with sensory expectations in product development is highlighted.



HMF of Samples	Ret. Time	Area	Conc.	Units
H158	9.086	30196	6.13 ± 0.02	mg/L
H214	9.132	128372	18.97 ± 0.03	mg/L
H365	9.159	44345	7.97 ± 0.02	mg/L

Figure 5. HMF Peaks in Halva Samples Determined by HPLC Chromatograms

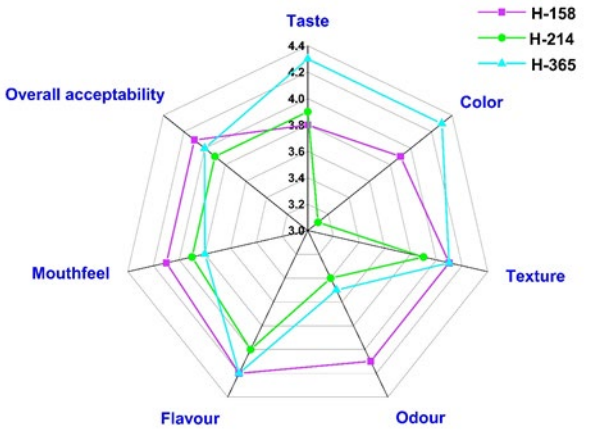


Figure 6. Sensory Evaluation Scores for Halva Samples Produced with Different Flours

Conclusion

The current study investigated the physicochemical, textural and sensory characteristics of conventional halva prepared with three distinct types of flour: white wheat (H-158), Kavılca (H-214) and corn flour (H-365). From both a gastronomic and a food science perspective, the results provide valuable insights into the impact of ancient and gluten-free grains on the quality and acceptability of traditional sweets. Of the formulations examined, white wheat flour demonstrated the highest values in terms of hardness, stickiness, chewability and elasticity. This occurrence can be ascribed to the elevated gluten content, a characteristic that plays a pivotal role in the establishment of the resilient and elastic structure that is indispensable for the creation of conventional confections (Alp baltakesmez & Mısır, 2025; Lucisano et al., 2012). Conversely, the use of Kavılca flour resulted in a product that was darker, less elastic, and harder, despite being nutritionally superior and rich in bioactive compounds. This is presumably a

consequence of heightened Maillard reaction activity, given that the highest HMF (18.98 mg/L) and browning index values were measured.

Elevated HMF levels have been evidenced to be correlated with diminished antioxidant capacity and prospective toxicity (Capuano & Fogliano, 2011; Evdokimov et al., 2015). These findings may give rise to concerns with respect to thermal load and nutrient degradation. Sensory evaluations further emphasised the importance of familiarity and textural comfort in consumer preference for traditional products. White wheat flour-based halva having been found to be the preferred option in terms of taste, texture, and overall acceptability, corn flour-based halva was a surprising second, despite its lower instrumental hardness. This was particularly evident in the results relating to mouthfeel and colour. This finding is consistent with previous research that suggests softer textures can enhance the perceived taste of confectionery products, particularly when consumed without experiencing chewing fatigue (Szczesniak, 2002; Pastoriza de la Cueva et al., 2017). With regard to culinary innovation, it has been demonstrated by the research that improvements in nutritional value (through the incorporation of ancient or gluten-free grains) must be balanced with sensory expectations and traditional textures. Although Kavılca flour provides functional and nutritional advantages, adding it to traditional halva may require the addition of texture-modifying ingredients such as pectin, guar gum, xanthan gum, agar-agar, cornstarch in different proportions, such as walnuts, hazelnuts, and rice flour, or optimizing the process. These components may affect the HMF content and also alter the texture, flavor, and overall acceptability of the product. In conclusion, the study demonstrated that white wheat flour is the most suitable flour for halva production from both technological and sensory perspectives. However, while corn flour may be a visually and sensorially appealing, promising gluten-free alternative, ancient wheat varieties like Kavılca, though nutritionally promising, require further formulation improvements for broader gastronomic applications.

Declarations

Conflict of interest

The authors declare that there is no conflict of interest.

Author contributions

NA: Designed study, production of halva, conducting experiments, data collections and analysis.

DAB: Designed study analyzed the data by statistical program, production of halva, writing and reviewing the manuscript.

SM: Designed study analyzed the data by statistical program, production of halva, 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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