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Textural, Pasting and Thermal Properties of Traditional Maras Tarhana Produced with Cracked Wheat

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Highlights:
- Maras Tarhana
- Textural properties
- Thermal stability
- Viscosity

Keywords:
- Traditional Maras Tarhana
- Pasting properties
- TPA
- Thermal stability

ABSTRACT:

This study was designed to determine the morphology, functional groups, dough structure, textural and thermal properties of twelve different Maras Tarhana samples. SEM results showed that tarhana powders generally had an amorphous-oval structure. In the FTIR analysis, although each sample had the same content, it was determined that there was variability in functional groups and frequency intensities, which was thought to be caused by the difference in the ratio between the components used. The highest peak viscosity (191.00 cp), trough viscosity (53.00 cP) and breakdown viscosity (138.00 cP) values were measured in sample number 4 ($p<0.05$). The highest hardness value was in sample number 2 (176.72 g), and the lowest cohesion value was in sample number 11, with 0.50. In thermal analysis, the highest weight loss was detected in sample number 12 with 79.70%. The Tg temperature range of the samples varied between 33.43-70.16 ºC, and sample number 8 was found to be the most stable against agglomeration. The analysis results determined that the pasting and textural properties of the samples differed significantly, and the FTIR and TGA-DSC results also determined that there were chemical and thermal differences between the samples. This situation revealed that there is no standard production in Maras Tarhana. It is thought that this may be due to many factors such as the starch content of the flour used due to local production, the ratio of the materials used in the formulation, the order of adding the materials, the fermentation time and the drying method.

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INTRODUCTION

Tarhana, which is very popular and widely consumed in Turkish culture, is a grain-based fermented product produced by the addition of various vegetables and spices such as yogurt, grain flours/or cracked wheat, tomatoes and onions (Akan and Ocak, 2019). The ingredients and quantities used in making tarhana may vary depending on the geographical region where it is produced. For example, wheat flour, cracked wheat and semolina can be used separately or together in production, and grain and legume flours such as chickpeas, barley, rye, soy and corn can also be used in addition to wheat flour. The ratio of yogurt to wheat flour is usually 1:1; in some regions however yogurt quantity may be decreased or increased. In addition to the usage rate, whether the yogurt is set or stirred affects some basic properties of tarhana. For example, stirred yogurt increases acidity, while set yogurt increases protein content. In some productions, sour milk or skimmed curd can be used instead of yogurt (Ozdemir et al., 2007). In addition to the materials used in the production stage, fermentation and drying period (time and temperature) also affect the nutritional content, chemical structure and textural properties of tarhana (Calışkan Koc and Özcıra, 2019).

Tarhana is known as kishk in Syria, Lebanon, Egypt, Palestine and Jordan, kushuk in Iran and Iraq, trahanas in Greece, talkuna in Finland, thanu in Hungary and atole in Scotland (Keskin et al., 2022). Although the names of such products prepared by different methods vary from region to region, the use of grain and fermented milk is found in every formulation. Thanks to the addition of grain-fermented milk mixtures to these products, the animal protein content increases and the nutritional value improves (Ozdemir et al., 2007).

The majority of tarhana consumed in Türkiye is homemade, and commercial interest in its ready-to-use industrial production is increasing. The dough prepared for making tarhana is usually left to ferment for 1-7 days. At the end of the period, the drying process is started (under the sun or in the oven) and the dried tarhana is ground into powder (İbanoglu et al., 1995). Tarhana can be produced by lactic fermentation through lactic acid bacteria in yogurt, or by adding baker's yeast (lactic fermentation + yeast fermentation) to shorten the fermentation time. Fermentation with lactic acid bacteria and yeast activity is responsible for the formation of the unique acidic and sour taste of tarhana (Temiz and Tarakcı, 2017). Tarhana can be preserved for a long time without spoiling, especially thanks to its low moisture content and high acidity. In addition, it has an important place in the nutrition of children and patients, especially thanks to the vitamins, minerals and protein it contains (Komurcu and Bilgicli, 2022).

There are Tarhana varieties belonging to many regions of Türkiye, and significant differences between them not only in terms of content but also in terms of production methods (Özdemir et al., 2012). Maras Tarhana differs from known Tarhanas in terms of its production from cracked wheat, consumption method, structure and taste, and has different consumption styles due to the diversity of production methods (Sekkeli et al., 2015). Wheat split and yogurt are used in the making of Maras Tarhana. Unlike other tarhanas, yogurt is not added to the cooking phase in Maras Tarhana, but is added to the mixture later. This situation also confirms that Maras Tarhana is a local food with functional features in terms of nutritional value (Dayisoylu et al., 2003). First, half of the wheat is cooked; spices such as thyme and black cumin, which contribute to the aroma and nutritional value of tarhana, and yogurt are added and mixed. The mixture obtained in the production of Maras Tarhana is dried by laying on wicker exhibitions woven with reed sticks in the region called Cig. This process adds a special feature to Maras Tarhana (Sekkeli et al., 2015).

Consumption of Maras Tarhana starts from the first stages of the production process. It is consumed in the form of "oiling" by adding oil to the cooked split beforehand, and then as "added soup"

mixed with yogurt. After being placed on the wicker exhibitions for drying, it is consumed in its semi-dried form called “firik” (Semerci, 2010). Dried Maras Tarhana can be consumed all year long without any change in taste or appearance, provided that it is stored in a cool and non-humid place. For this reason, there are quite different consumption patterns in homes, especially in winter. For example; soup, soaked in water or broth, fried in oil with or without onions, is consumed both as a meal and as a snack with walnuts, almonds or fresh pistachios (Sekkeli et al., 2015).

Although there are many comprehensive studies in the literature to determine the properties of tarhana, there is very limited information about the traditional Maras Tarhana, which has many unique properties and is produced from cracked wheat. In this study, it was aimed to determine the dough, textural, morphological, thermal and molecular properties of homemade Maras Tarhana obtained from different producers.

MATERIALS AND METHODS

Materials

In this study, twelve homemade Tarhana samples obtained from local producers in Elbistan district of KahramanMaras province (Türkiye) were used. Approximately 250-300 g of the powdered Maras Tarhana samples were taken and put into sterile glass packages and quickly brought to the laboratory.

Methods

Scanning electron microscope (SEM)

The surface morphology of tarhana samples was examined by SEM (Zeiss Sigma 300 FESEM Oberkochen, Germany). Samples were mounted on a carbon plate for conductivity before analysis. It was then coated with palladium at room temperature and imaged at 10000 kV.

FTIR

The spectra of tarhana samples were recorded at room temperature using an Infrared Spectrometer (IRAffinity-1S, Shimadzu) equipped with an ATR prism crystal accessory set to standard parameters (3500-400 1/cm) on powder samples. For measurements, potassium hydroxide containing 1/100 sample/KBr was used. bromide pellets were prepared and ground by mixing in a mortar. FTIR curves of the samples were recorded with 16 full-speed scans and 4 1/cm resolution. OPUS (v. 5.5. Bruker Optics, Germany) was used to process the obtained data.

Pasting properties

Pasting properties of the tarhana samples were determined using rapid viscosity analyzer (RVA) (Perten Instruments, Australia). Briefly, 25 ml of water was added to 3 g of the tarhana sample and heated to 50 °C at 160 rpm and kept at this temperature for 1 minute. Then, the samples were heated to 95°C (at a rate of 13.16°C/min) and cooled to 50°C (at a rate of 7.28°C/min) by waiting at this temperature for 5 minutes. Pasting parameters were calculated via Thermocline Windows software (Perten) (Yildiz et al., 2017).

Textural properties

Texture Profile Analysis (TPA) measurement (TAXT2i; Stable Micro Systems Ltd.) was applied to determine the textural structure of the tarhana gels in water (Yildiz et al., 2013). Before analysis, the prepared gels were kept at room temperature for 3 hours. A P/25 cylindrical probe and a 5 kg load cell were used for tissue measurement. The deformation distance, test speed, and trigger force were set to 5 mm, 1 mm/s, and 5 g, respectively. All measurements were repeated three times for each sample and calculation was performed using Texture Exponent Programs (Texture Exponent v. 2.0.7.0.).

Thermogravimetric analysis (TGA)

TGA curves of the tarhana samples were measured using a thermogravimetric analyzer (Setaram Labsys Evo Thermal Analyzer) with a heating rate of 10 ºC/min. The analysis was carried out in the temperature range from 25 to 550 ºC and argon was used as the transfer gas.

Differential scanning calorimetry (DSC)

DSC is used to obtain calorimetric information to evaluate the thermal transition of food systems. For analysis, 1-4 mg of tarhana sample was hermetically sealed in a DSC (Mettler Toledo Co., Switzerland) aluminum pan. Heating of the samples was carried out at a heating rate of 10 °C/min, and the highest transition temperature (Tg) was reported as endothermic peaks.

Statistical analysis

The results were interpreted with one-way analysis of variance (ANOVA) and Duncan post hoc test ($p < 0.05$) using the Statistical Package for the Social Sciences (SSPS) package program (version 18).

RESULTS AND DISCUSSION

SEM Micrographs of the Tarhana Samples

Micrographs of tarhana powders obtained by SEM are shown in Fig. 1. Most of the samples (except 7, 11 and 12) have an amorphous-oval structure. Post-production drying of tarhana is generally done by traditional methods or at temperatures not exceeding 50 °C. At these temperatures, gelatinization of the starch in the structure is not sufficient and causes the structure to be observed in oval form (Majzoobi et al., 2011). Based on this, it can be said that the oval structures in the images are ungelatinized starches. The flat layers seen in samples 7, 11 and 12 are thought to originate from gelatinized starch due to the high temperature baking process applied to tarhanas after drying (Goncu and Celik, 2020). In the research conducted by Salameh et al. (2016) on kishk, irregular structures were mentioned in the SEM images of particles smaller than 100 μm. In addition, SEM images showed that certain parts of the samples were covered with a layer thought to be an oil layer. Although tarhanas generally have low oil content, the presence of oil layers in certain parts of the particles in SEM images has been confirmed in similar studies (Goncu and Celik, 2020).

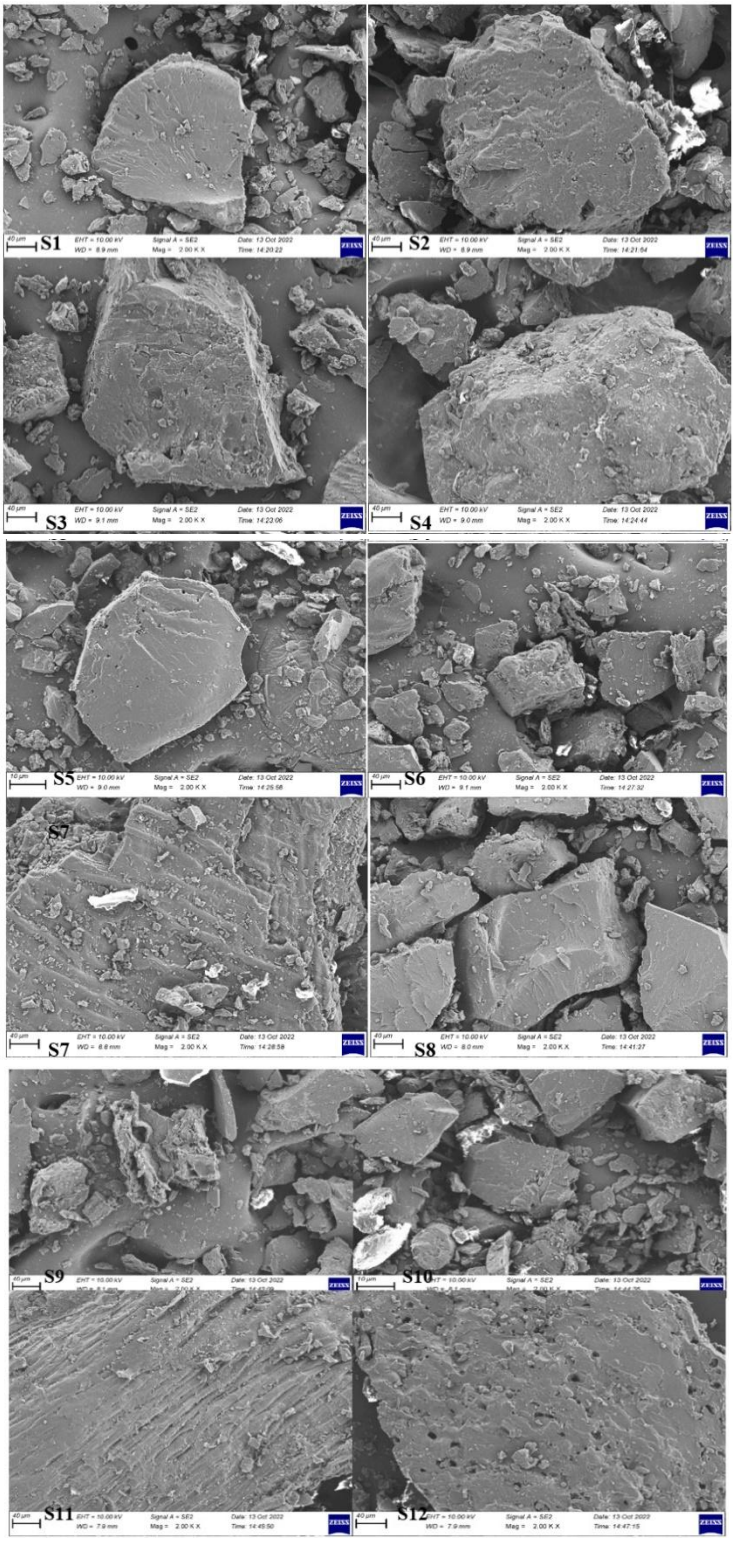

Figure 1. SEM images of the Maras Tarhana samples

FTIR Analysis of the Tarhana Samples

FTIR analysis is one of the most common methods used to identify functional groups. The spectra of the samples obtained in the FTIR analysis are shown in Fig. 2. Although there are regional production differences, the main components of tarhana include basic components such as water, carbohydrates, fat, protein, minerals and salt, as well as secondary components such as vitamins, ascorbic acid and agents such as lactic acid bacteria. According to FTIR data, the 2924 1/cm band where the maximum absorbance is obtained is due to the N-H stretching of amide groups in proteins and partly to the O-H

stretching of carbohydrates. The bands at 2360 and 2849 1/cm in the FTIR spectrum are related to the stretching vibrations of methylene groups and can mainly originate from lipids. However, it was reported that the bands seen in the mentioned range in tarhana belong to vitamin complexes resulting from the asymmetric CH_2 stretching mode (Bardakci and Masoero, 2013). This region is called the lipid or vitamin region (Baltacıoglu et al., 2021). This area is probably due to vitamins, as tarhana generally does not contain high amounts of lipids in its composition. It is seen that there is variability in the frequency intensities of the functional groups in the examples. This is thought to be due to the difference in the ratio between the components used, even though each sample has the same content. The bands observed at 1650 and 1747 1/cm can be attributed to peaks arising from C=O stretching vibrations and expressing ascorbic acid (Baltacıoglu et al., 2021). The bands located in the region between 1048-1650 1/cm are Amide I (C=O stretching band) and Amide II (N–H deformation band) bands, respectively, depending on the proteins (Baltacıoglu et al., 2021). In tarhana samples, the maximum signal at 1048 1/cm originates from the C=O bond in the COH group and also from carbohydrates (Baltacıoglu et al., 2021). On the other hand, studies have reported that the amount of ingredients used in making tarhana, the order of addition, and processing techniques can affect its chemical composition and vibration frequency (Bardakci and Masoero, 2013).

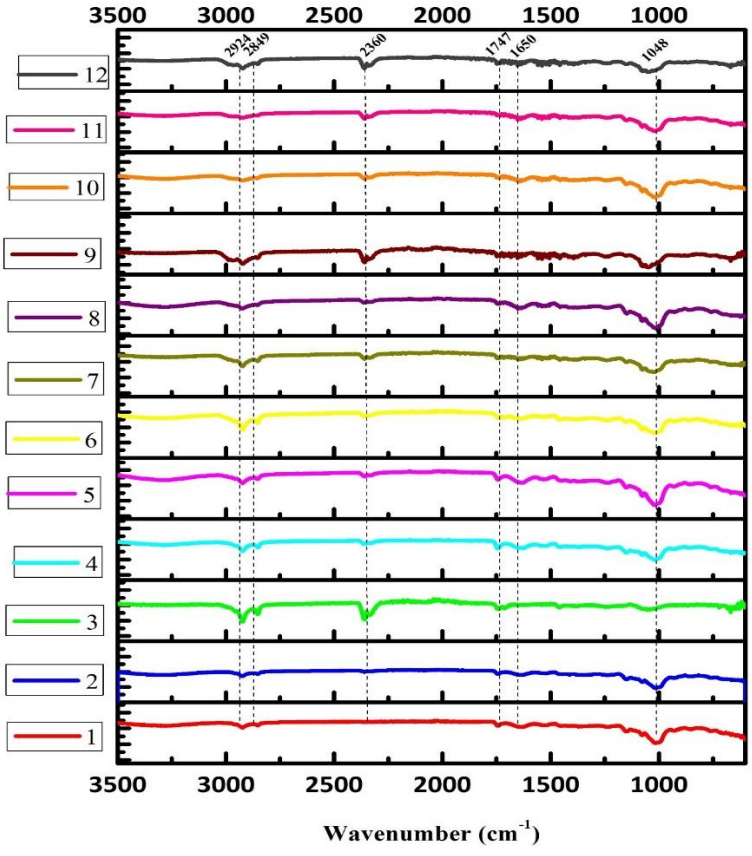

Figure 2. FTIR spectra of the Maras Tarhana samples

Pasting Properties of the Tarhana Samples

Viscosity values are an important criterion in terms of the taste of tarhana and its acceptability by the consumer. Pasting properties of tarhana samples are presented in Table 1. It is seen that the PV values of the samples are in the range of 6.50-191.00 cP and vary considerably among themselves ($p<0.05$). The lower PV value is due to lower starch content and higher starch damage (Simsek et al., 2014). In samples with high PV value, most of the starch granules are fully swollen and the granules in this state

interact with each other, causing the viscosity to increase. Especially as seen in example number 4, high PV value indicates the presence of large-sized granules. TV values of tarhana samples vary between 1.00-53.00 cP ($p<0.05$), and in parallel with the PV results, the highest TV value belongs to sample number 4. This value is affected by granule swelling, amylose-lipid complex and amylose leakage (Kaushal et al., 2012).

Table 1. Pasting properties of Maras Tarhana samples (mean ± standard deviation)

Sample No	PV (cP)	TV (cP)	BV (cP)	FV (cP)	SV (cP)	PeT (min)
1	36.00±.00DE	25.00±1.41^{DE}	11.00±1.41^{AB}	72.00±2.83^{D}	47.00±4.24^{E}	7.00±0.00^{A}
2	48.50±9.19^{E}	41.00±7.07^{F}	10.00±1.41^{AB}	118.00±11.31^{F}	82.00±2.83^{H}	6.67±0.09^{A}
3	17.00±4.24^{ABC}	8.50±0.71^{BC}	8.50±3.54^{AB}	48.50±2.12^{C}	40.00±1.41^{CDE}	6.90±0.04^{A}
4	191.00±8.49^{F}	53.00±5.66^{G}	138.00±2.83^{C}	65.00±4.24^{D}	12.00±1.41^{A}	6.97±0.05^{A}
5	6.50±2.12^{A}	1.00±1.41^{A}	5.50±0.71^{A}	41.00±2.83^{BC}	40.00±1.41^{CDE}	6.90±0.04^{A}
6	49.50±0.71^{E}	31.00±0.00^{E}	18.50±0.71^{B}	95.00±1.41^{E}	64.00±1.41^{F}	6.73±0.37^{A}
7	8.00±1.41^{A}	11.50±0.71^{C}	3.50±0.71^{A}	9.00±1.41^{A}	20.50±0.71^{B}	6.40±0.66^{A}
8	12.00±4.24^{AB}	1.00±1.41^{A}	11.00±2.83^{AB}	45.50±3.54^{C}	44.50±2.12^{DE}	6.87±0.09^{A}
9	28.50±13.44^{CD}	9.00±1.41^{BC}	19.50±14.85^{B}	47.00±1.41^{C}	38.00±0.00^{CD}	6.70±0.14^{A}
10	6.50±2.12^{A}	3.50±2.12^{AB}	10.00±0.00^{AB}	32.50±2.12^{B}	36.00±0.00^{C}	6.73±0.28^{A}
11	22.50±0.71^{BCD}	10.50±0.71^{C}	12.00±0.00^{AB}	74.00±4.24^{D}	63.50±4.95^{F}	6.94±0.09^{A}
12	34.00±7.07^{D}	24.00±1.41^{D}	10.00±5.66^{AB}	96.50±10.61^{E}	72.50±9.19^{G}	6.90±0.04^{A}

Values in each column with different superscripts are significantly different ($p < 0.05$). PV= peak viscosity, TV= trough viscosity, BV= breakdown viscosity, FV= final viscosity, SV= setback viscosity, PeT= peak time.

After the starch granules are completely swollen, a deterioration occurs. After this degradation, starch molecules (amylose and amylopectin) are released into the solution and the viscosity decreases. This degradation is known as BV and it shows significant differences between 3.50-138.00 cP in the tarhana samples examined ($p<0.05$). Especially in the sample number 4 examined, as a result of the high BV value, starch granules are more sensitive to shear and break down more easily. In addition, the low BV value in other samples indicates the high shear stability of the sample and it is desired that this value be low in soup products (Acevedo et al., 2013). The BV value in tarhana samples was reported by Shevade et al. (2019) as 1.61 Pas, which is quite high compared to Maras Tarhana.

The FV value measures the potential of the structure to form a viscous paste as affected by the retrogradation of soluble amylose after cooling of the samples (Kaushal et al., 2012). FV values of the samples ranged between 9.00-118.00 cP ($p<0.05$). Sample number 7 has the lowest FV and BV values. This is likely due to a decrease in swelling factor due to higher sugar concentration in the materials used during production and various factors such as sugar-starch interactions that limit starch hydration (Sharma et al., 2009).

SV values of the samples ranged between 12.00-82.00 cP ($p<0.05$). The lowest value belongs to sample number 4 and the highest value belongs to sample number 2. A high SV value is an indication of the higher starch content of tarhana (Wang et al., 2015). The low tendency to return is advantageous in soups that experience viscosity and sedimentation loss. Differences in SV between samples are due to differences in molecular size, amylose fraction, amylose/amylopectin ratio, and pH of the samples (Acevedo et al., 2013). Resistant starches have lower swelling and less amount of leached amylose. In this case, the amylose molecules are not sufficient to recombine to form a viscous gel, causing a decrease in FV and SV (Acevedo et al., 2013). The high FV and SV values observed in sample number 2 are an indicator of the resistant starch present in the structure. Additionally, sample 4, with its lower SV value

and higher PV, is less prone to retrogradation. The SV values obtained are significantly lower than the results reported by Shevade et al. (2019) on tarhana (1.58 Pas).

PeT value was similar in all tarhana samples ($p>0.05$). This shows that the reactions of resistant starch in the samples against swelling and tearing are close to each other. Shevade et al. (2019) determined the PeT value of tarhana samples as 10.98 min, and this value is higher than Maras Tarhana. In general, differences in the dough properties of tarhana samples vary depending on the starch concentration of the flour used, amylose-amylopectin ratio, amylose-lipid complexes and the length of fermentation (Wang et al., 2015).

TPA of the Tarhana Samples

TPA results of Maras Tarhana samples are given in Table 2. The highest hardness value is in sample number 2 with 176.72 g. Results vary considerably between samples ($p<0.05$). Retrogradation of starch and crystallization of amylopectin are the main factors affecting the hardness of the structure. Harder starches have higher amylose content and longer amylopectin chains (Yildiz et al., 2017). In parallel with the SV results, the higher amount of resistant starch in sample number 2 compared to the other samples resulted in a higher hardness value. It is also thought that the differences in the hardness values of the samples may be due to the variability in the dry matter content.

Table 2. Textural properties of Maras Tarhana samples (mean ± standard deviation)

Sample No	Hardness (g)	Adhesiveness (g.s)	Springiness (mm)	Cohesiveness	Gumminess (g)	Chewiness (g mm)	Resilience
1	58.50 ± 3.03^{B}	-2.46 ± 0.59^{DE}	3.60 ± 0.06^{C}	0.88 ± 0.01^{F}	51.55 ± 3.21^{CD}	185.39 ± 15.13^{B}	0.09 ± 0.01^{CD}
2	176.72 ± 67.58^{C}	-24.63 ± 5.27^{BC}	3.52 ± 0.06^{C}	0.70 ± 0.01^{D}	122.11 ± 45.53^{E}	430.94 ± 167.25^{D}	0.10 ± 0.02^{DE}
3	6.23 ± 2.8^{A}	-2.57 ± 0.18^{DE}	3.91 ± 0.01^{C}	0.89 ± 0.01^{F}	114.10 ± 2.12^{E}	20.12 ± 2.23^{D}	0.14 ± 0.00^{FG}
4	7.97 ± 1.05^{A}	-26.26 ± 3.42^{B}	0.99 ± 0.00^{A}	0.62 ± 0.01^{BC}	4.93 ± 0.52^{AB}	4.86 ± 0.51^{A}	0.04 ± 0.00^{AB}
5	1.03 ± 0.11^{A}	-0.45 ± 0.01^{E}	3.36 ± 0.04^{C}	0.79 ± 0.00^{E}	0.82 ± 0.09^{A}	2.72 ± 0.27^{A}	0.14 ± 0.01^{FG}
6	57.95 ± 2.52^{B}	-53.05 ± 1.79^{A}	0.98 ± 0.01^{A}	0.60 ± 0.04^{B}	34.02 ± 0.27^{BC}	33.49 ± 0.42^{A}	0.03 ± 0.02^{A}
7	0.66 ± 0.00^{A}	-0.01 ± 0.00^{E}	3.48 ± 0.00^{C}	0.68 ± 0.03^{D}	0.45 ± 0.01^{A}	1.56 ± 0.06^{A}	0.16 ± 0.03^{G}
8	3.66 ± 1.17^{A}	-8.11 ± 4.55^{D}	1.83 ± 1.18^{B}	0.70 ± 0.04^{D}	2.53 ± 0.69^{AB}	4.21 ± 1.73^{A}	0.07 ± 0.01^{BC}
9	5.92 ± 0.99^{A}	-20.62 ± 4.86^{BC}	0.99 ± 0.00^{A}	0.65 ± 0.03^{CD}	23.84 ± 0.49^{ABC}	3.80 ± 0.48^{A}	0.06 ± 0.01^{AB}
10	0.73 ± 0.13^{A}	-5.79 ± 0.13^{DE}	5.79 ± 0.12^{D}	0.89 ± 0.02^{F}	19.17 ± 0.71^{AB}	3.44 ± 0.02^{A}	0.04 ± 0.00^{AB}
11	6.32 ± 0.06^{A}	-19.24 ± 0.49^{C}	0.99 ± 0.00^{A}	0.50 ± 0.01^{A}	3.14 ± 0.06^{AB}	3.10 ± 0.06^{A}	0.05 ± 0.00^{AB}
12	88.58 ± 4.04^{B}	-0.82 ± 0.45^{E}	3.93 ± 0.02^{C}	0.88 ± 0.03^{F}	77.84 ± 1.28^{D}	305.63 ± 3.26^{C}	0.12 ± 0.01^{EF}

Values in each column with different superscripts are significantly different ($p < 0.05$).

The highest adhesiveness value was measured in sample number 6 with -53.05 g.s. The lowest value was detected in sample number 7 (0.01 g.s). The decrease in adhesiveness has been reported to be due to the formation of a weak three-dimensional network caused by the increase in hydrocolloid concentration (Hosseini and Ansari, 2019).

Springiness is an indicator of how well a sample can return to its original form after initial deformation. It was determined that sample number 10 had the highest springiness value with 5.79 mm. The high springiness value is due to the gelatinization of starch by the joint effect of proteins and polysaccharides (Sun et al., 2019).

The highest cohesiveness value was determined as 0.89 in samples 3 and 10. It was revealed that sample number 11, which had the lowest cohesiveness value (0.50), had a high tendency to textural damage and had a plasticity structure. In general, high cohesiveness value indicates the formation of a good gel structure, increasing the acceptability of starchy foods (Teng et al., 2013). The gumminess

value is obtained by multiplying the hardness and cohesiveness values. The highest gumminess value belongs to sample number 2 (122.11 g). This high gumminess value is due to the fact that this parameter is related to the hardness parameter (Celik and Isık, 2023).

Chewiness value is the net energy required to chew and swallow food and is obtained by multiplying hardness x springiness x cohesiveness. The highest chewiness value is in sample number 2, similar to the gumminess results. Finally, the resilience values of the samples vary between 0.03-0.16. Sample number 7 has the highest resilience value but the lowest gumminess value.

TGA and DSC of the Tarhana Samples

Thermogravimetric curves of tarhana powders heated from 25 to 550 °C are given in Fig. 3. The weight decreases up to 100 ºC occurred due to water loss. Although the powders are dry, this is because not all of the free water can be removed by the drying process applied to the samples and the powder samples have absorbed moisture from the environment. Weight loss at 100-250 ºC is due to the deterioration of the structure of tarhana samples and the loss of C=O and C=C bonds (Liu et al., 2019). The highest weight loss was 79.70% in sample number 12, and the lowest weight loss was 52.26% in sample number 5. In the temperature range of 250-600 ºC, the degradation of powder particles increased more and then reached equilibrium. The highest weight loss in the samples occurred around 250 ºC. This shows that tarhana samples have a high potential for use in foods that require heat treatment (Kavitake et al., 2019).

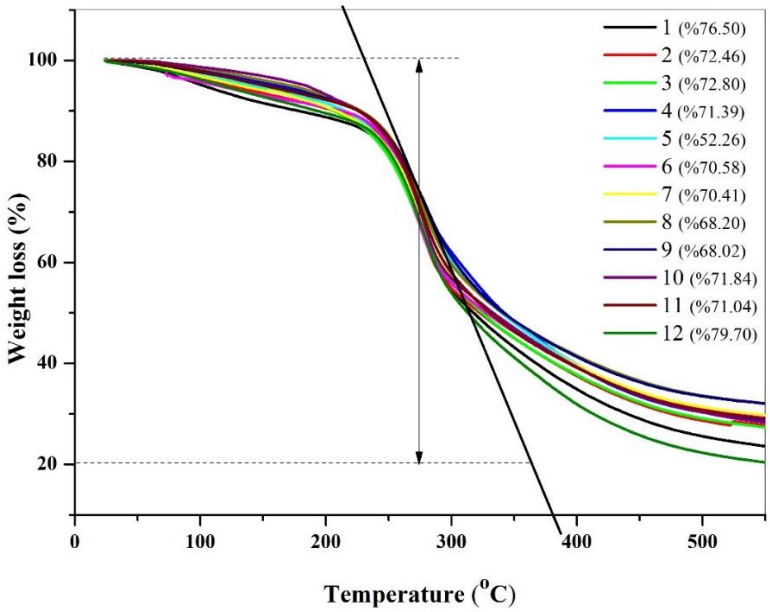

Figure 3. TGA curves of the Maras Tarhana samples

The temperature at which an amorphous structure transitions from the glassy state to the viscous state is the glass transition temperature (Tg). Fig. 4 shows the DSC curves and Tg values of the samples. The highest Tg temperature belongs to sample number 7 with 70.16 ºC. The lowest value was measured in sample number 8 with 33.43 ºC. Although powder particles are stable at temperatures below Tg, undesirable changes such as precipitation, stickiness and agglomeration of amorphous powders occur above this temperature (Kavitake et al., 2019). Based on this, it was determined that sample number 8 had the highest stability against agglomeration. However, samples 2 and 5 had lower stability compared to other samples. The differences observed between the Tg values of the samples may be due to the different fermentation time of tarhanas affecting the structure of starch. In addition, starch concentration, amylose-lipid complexes, granule size, granule heterogeneity, amylose/amylopectin ratio used in the

production of tarhana have an impact on the transition temperatures of tarhana samples (Simsek et al., 2014).

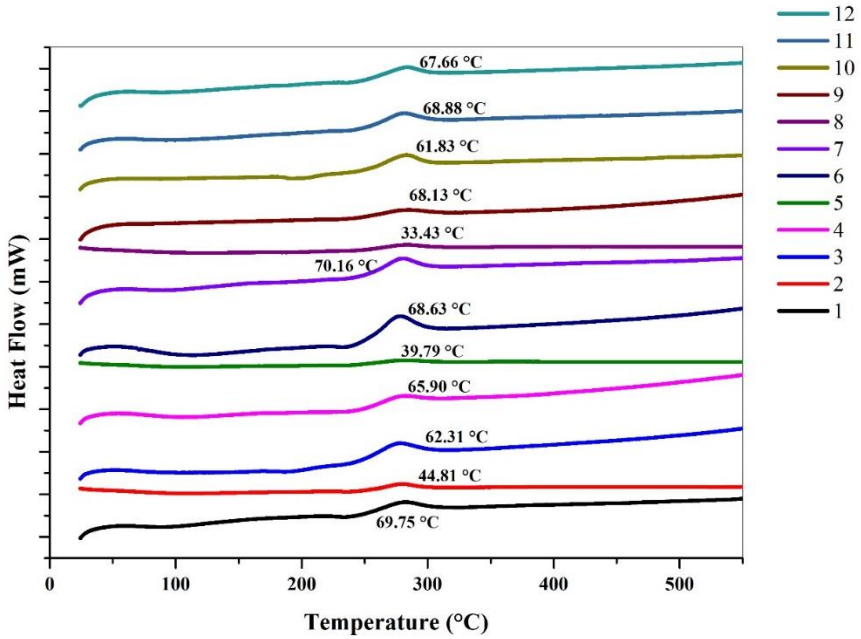

Figure 4. DSC measurement and Tg values of the Maras Tarhana samples

CONCLUSION

Home-made tarhana is a cultural heritage, and today its commercial production has become widespread and its sale has become an economic input. Changes in lifestyle and eating habits have made traditional foods the most suitable option for a healthy life. Tarhanas with very different quality characteristics are obtained due to factors such as raw material quality, formulation differences and application diversity, which vary from region to region. In this study, the morphological structure, organic functional groups, pasting, textural and thermal properties of twelve different Maras Tarhanas obtained from local producers were examined. In the results obtained, it was determined that the pasting and textural properties of the tarhanas sold under the name Maras Tarhana vary considerably. Similarly, FTIR and TGA-DSC results revealed chemical and thermal differences between the samples. This situation is an indication that there is no single standard in the production of Maras Tarhana. It is thought that the differences between the samples may be due to many factors, including the formulation used, fermentation time, starch concentration of the flour used, drying method, and the order in which the materials are added during the production phase. In future studies, in order to minimize the existing differences, it is recommended to investigate the production possibilities of this local product using a fixed recipe and standardized parameters. In this way, it is thought that an important step will be taken in the commercialization of Maras Tarhana, a traditional product.

Conflict of Interest

The article authors declare that there is no conflict of interest between them.

Author's Contributions

The authors declare that they have contributed equally to the article.

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